TENCOR® PROFILERS
P-10, P-11, P-12, P-22, P-30

SERVICE AND MAINTENANCE MANUAL

Tencor

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Text & Binder	#S411256-27		4/97

For Use in Class 100 Clean Rooms

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Trademarks

Patents

This instrument is protected under the following patent: 5134303.

Figure i-1. *Tencor P-22 Surface Profiler*

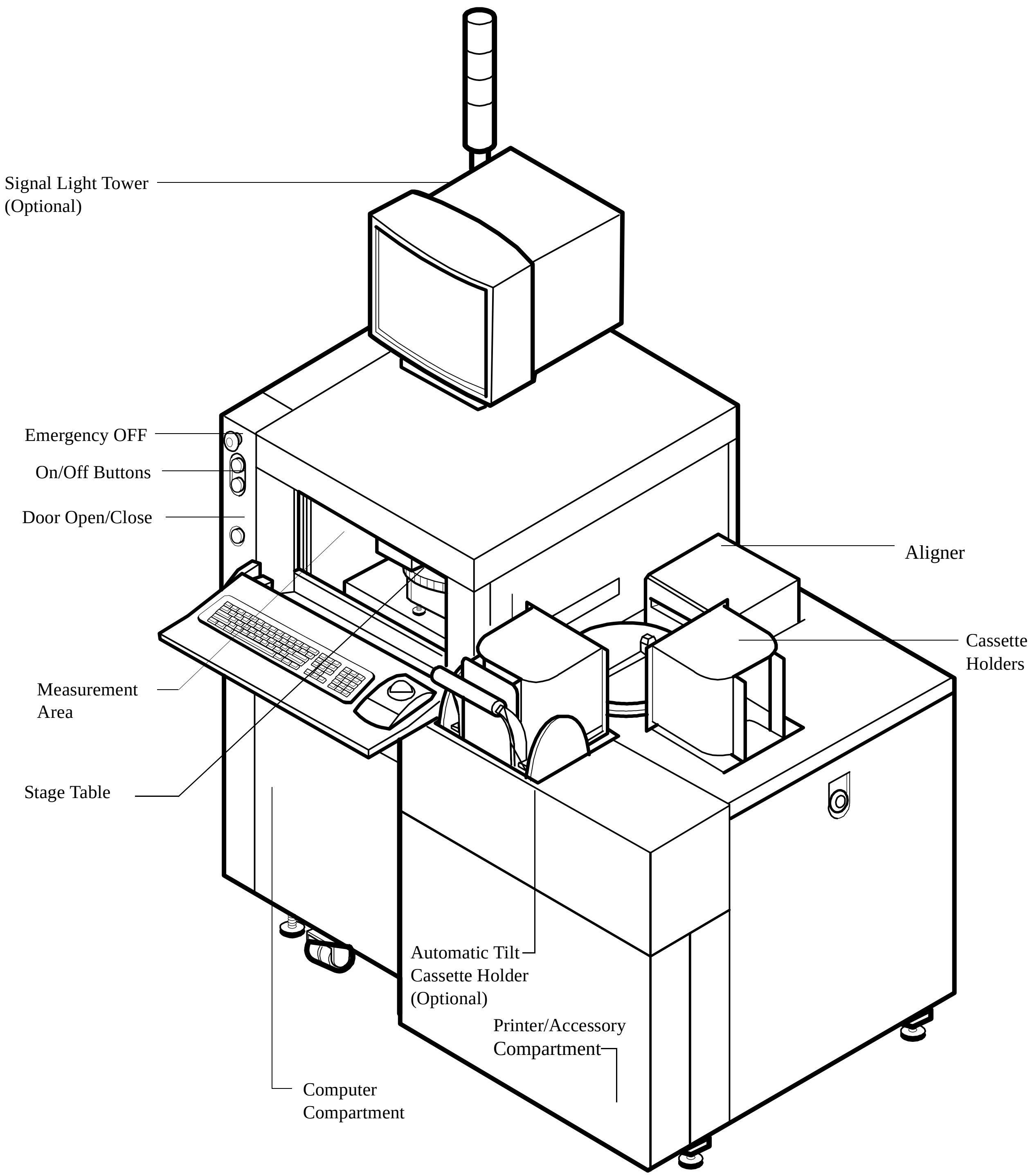


Figure i-2. *Tencor P-11 Long Scan Profiler*

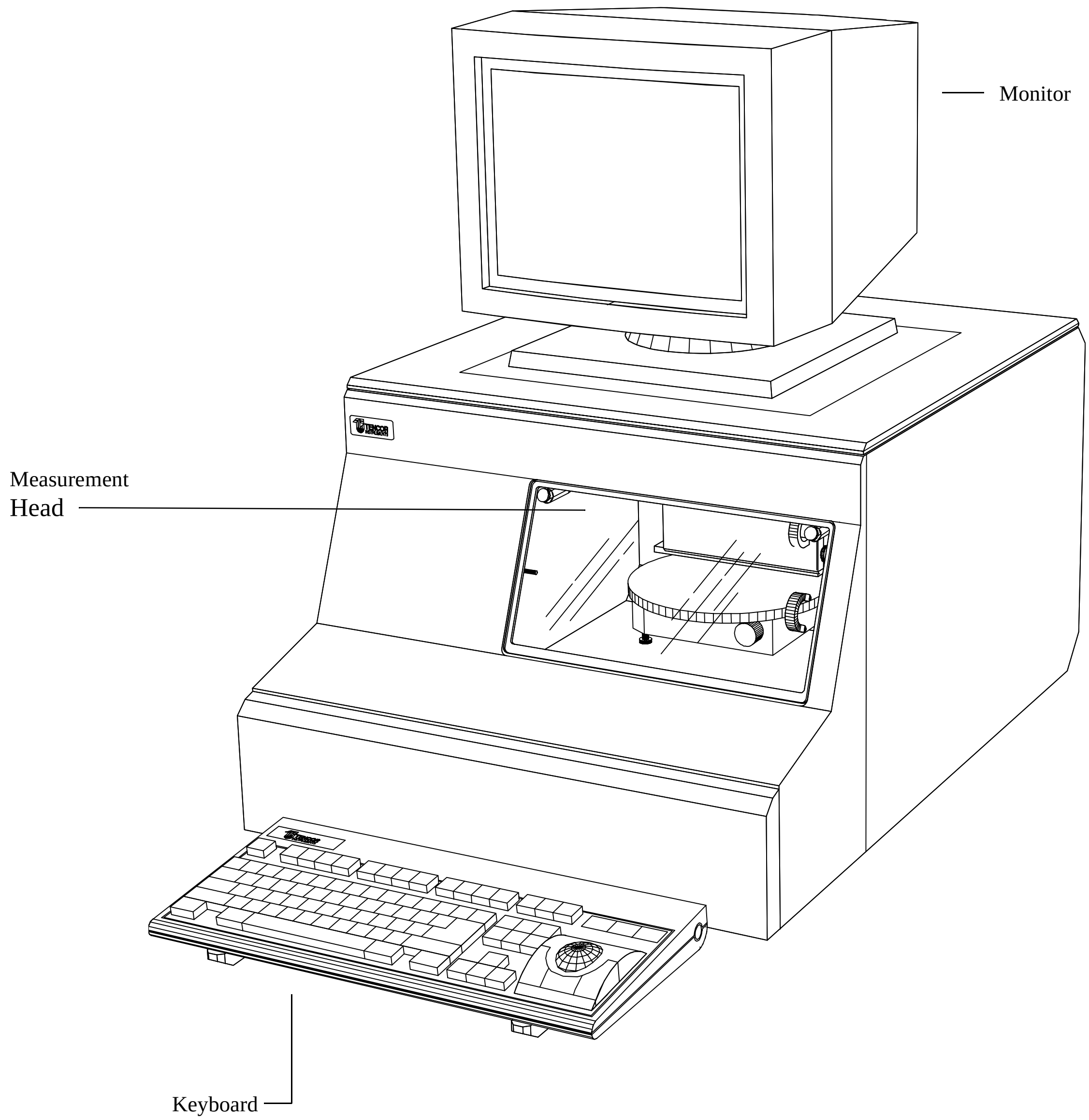


Figure i-3. *P-12 Disk Profiler*

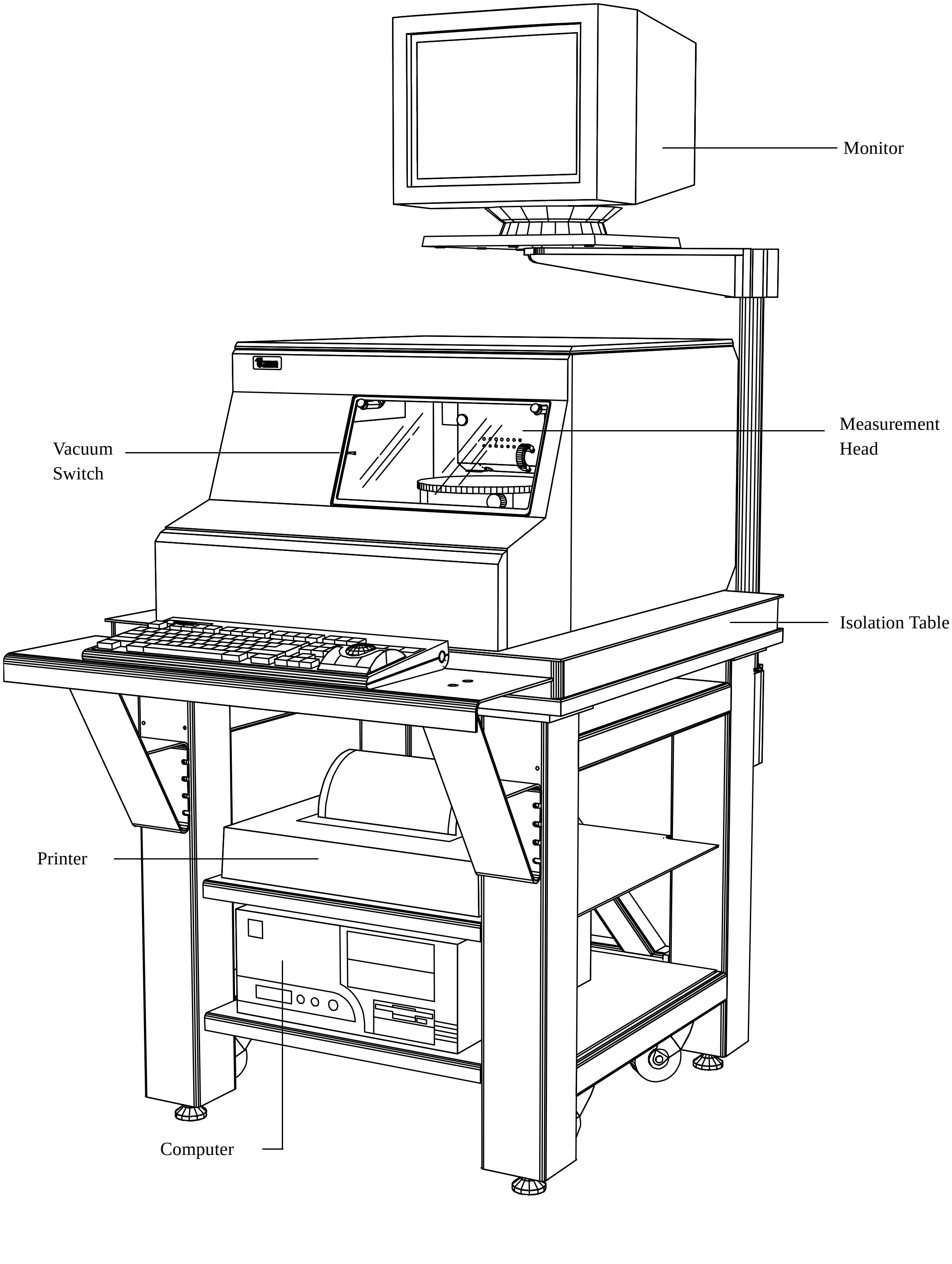
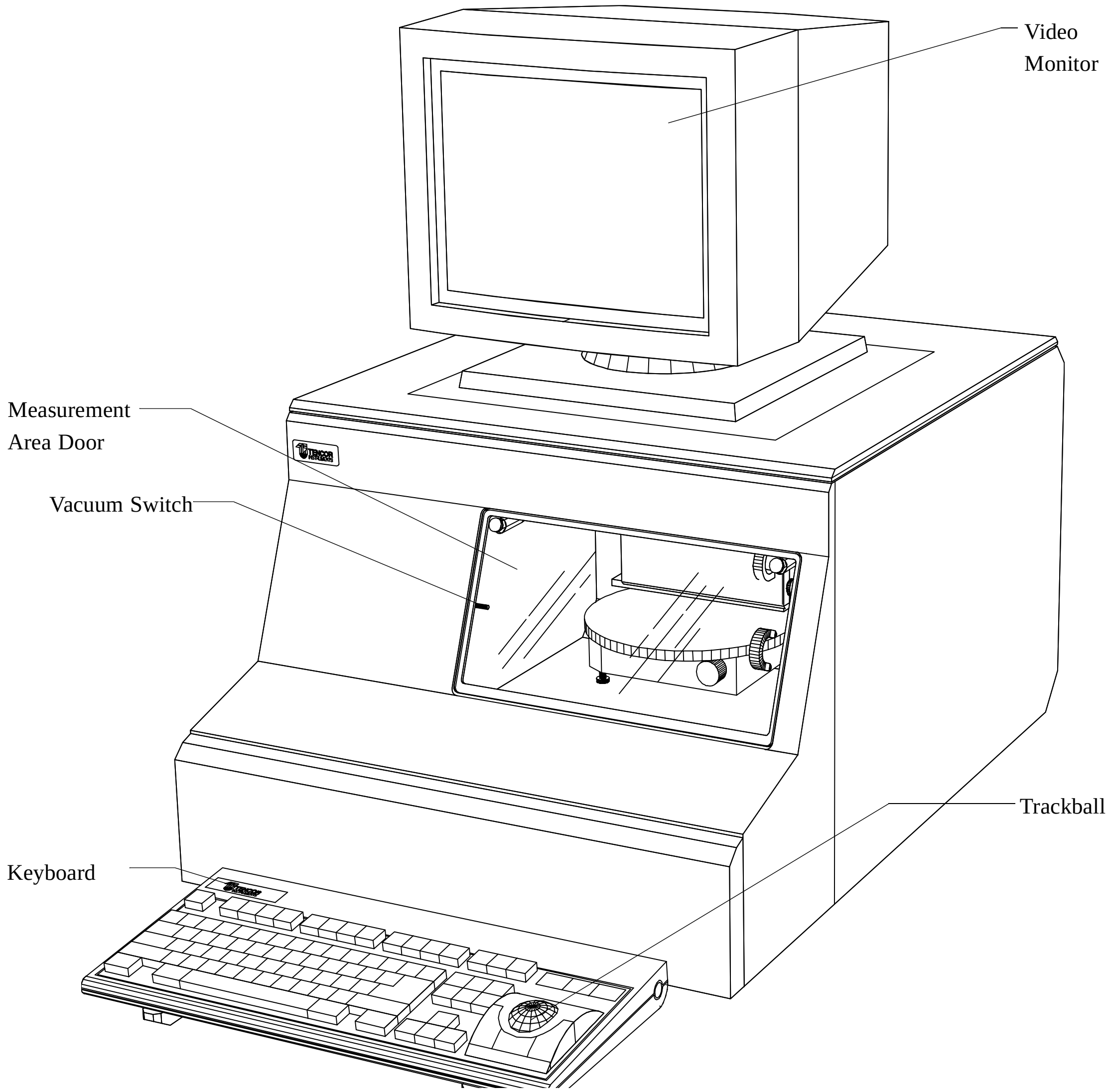


Figure i-4. *P-10 Surface Profiler*



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WELCOME FROM TENCOR INSTRUMENTS

It is assumed that you are familiar with the Microsoft® Windows™ and Disk Operating System (DOS). If you are not, please refer to the Windows and DOS documentation provided with your instrument.

This manual explains the following Tencor products:

- The P-10 Profiler
- The P-11 Profiler
- The P-12 Profiler
- The P-22 Profiler
- The P-30 Profiler
- How to Use This Manual

To get the most out of this documentation, work sequentially from Chapter 2, "Tencor Profiler Installation" through Chapter 6, "Linearity Adjustments" (note that there are procedures throughout this manual for both Windows 3.11 and DOS).

The program runs in either Windows 3.11 or DOS (remember to make certain you follow the instructions according to your operating system).

The mechanical procedures (Chapter 5, "Mechanical Alignments"), the MicroHead II, and the Linearity table (Chapter 6, "Linearity Adjustments") are the same for these profilers.

Use Chapter 3, "Hardware Maintenance (DOS)" or Chapter 4, "Hardware Maintenance (Windows)" according to which operating system you use to perform hardware maintenance.

Chapter 8, "Troubleshooting Guide" discusses the best methods to isolate and repair problems with the profiler. Chapter 9, "Diagnostic Diskette" provides supporting software for diagnostic purposes.

The appendices are provided for general reference.

Documentation Conventions

This section provides examples of the conventions used in this manual.

Typographic Conventions

The following typographic formatting and symbols are also used throughout this manual.

Format	Meaning
Upload button	A button that you click on in a dialog box or a mechanical button you press on the instrument (e.g., **Power On** button).
C:\ORCA\USER1	Text that must be typed exactly as shown, such as directory, file, and path names, or DOS commands.
Low Intensity text box	Options or fields in a dialog box or window.
CTRL+P	Keys pressed simultaneously. The plus (+) symbol indicates that you must hold down the first key, press the second key, and then simultaneously release both keys.
TAB, DELETE	Keys pressed sequentially. The comma (,) indicates that you must press one key at a time, one after the other.

Terminology

Terminology used throughout this manual follows the conventions established in the Microsoft Windows and DOS *User's Guide*.

P/N S411248 Rev. A
4/97

1

FUNCTIONAL DESCRIPTION

The MicroHead II control board provides all electronics for the measurement head, the complete analog electronics, and A/D for the LVDC sensor. The MicroHead board provides motor drivers for the drop and zoom motors, and connections for all electronic components.

The MicroHead board connects to the UPI board (Assy. 231681) by way of a Scan Box Interface (Assy. 231703). The MicroHead board is compatible with older systems as long as they have a UPI board.

Inside the head, the MicroHead board connects to the LVDC, the force coil, the proximity sensor, the TV camera, the lamp(s), the temperature sensor, and the drop and zoom motors, and their shaft encoders and home switches.

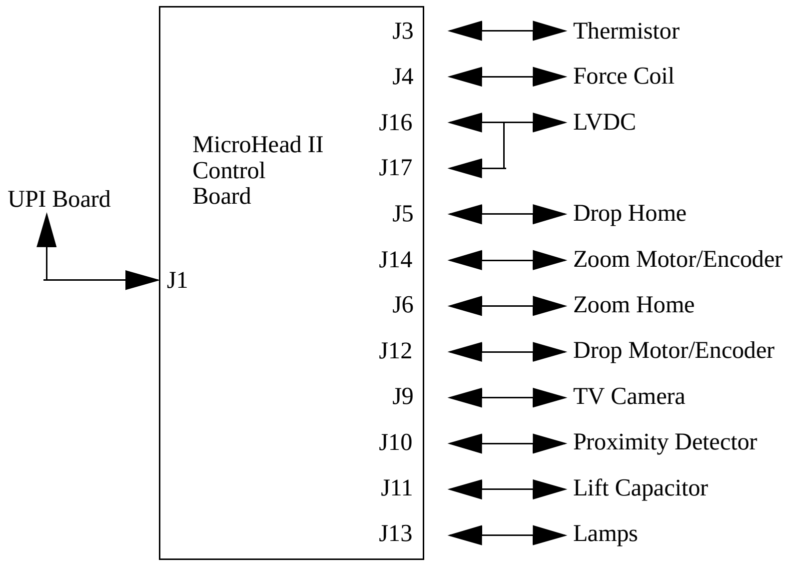
New capabilities are:

- Higher resolution/lower noise measurements
- Higher sample rates
- Finer force control
- Software controllable auto-iris lamp driver
- Proximity sensor support
- Ability to run on 12- or 15-V power supply
- Temperature sensor
- Full motion control for the stylus drop and zoom motors

MicroHead II Control Board

The figure below is a block diagram showing the connection of the MicroHead II with the other boards of the instrument. For clarity, connections from address decoders, clocks, or power supplies are not shown.

Figure 1-1. *MicroHead II Control Board*



Following is a block diagram of the MicroHead II Control board, accompanied by a table describing the function of each block.

Figure 1-2. *The MicroHead II Control Board Block Diagram*

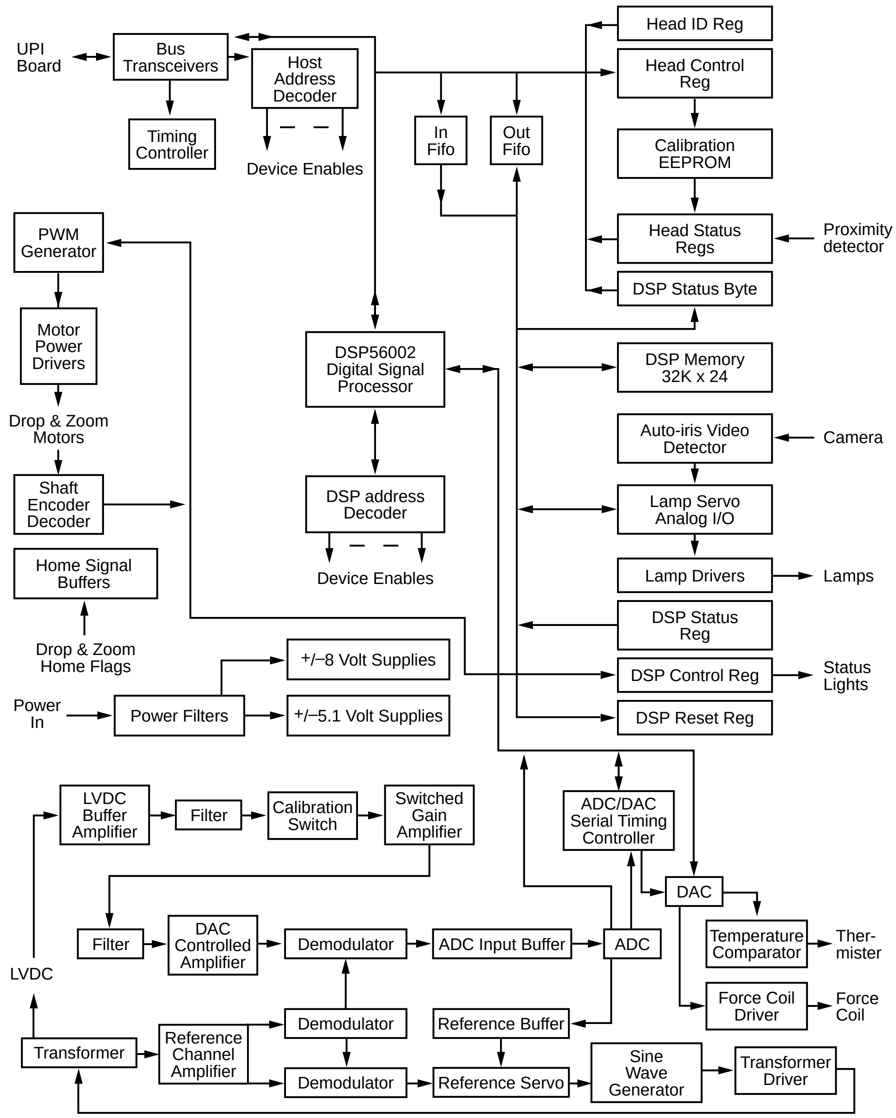


Table 1-1. *Descriptions of Figure 1-2, The MicroHead II Control Board Block Diagram*

Function	Description
Sine wave generator	The 50 kHz sine wave is generated in an 8-bit digital form. A D/A converter transforms the signal to a sampled 50 kHz sine wave. An analog filter removes the small steps in the sampled wave form, producing a pure sine wave.
Transformer Driver	Converts the 50 kHz sine signal into a differential 7 or 14 V peak to peak drive to the transformer.
Reference channel amplifier	Amplifies and filters the adjusted reference output of the front-end amplifier. Demodulates the 50 kHz sine wave to a DC signal. The DC reference channel signal is fed back to the reference servo amplifier.
Demodulator driver	Takes the sine wave signal from the reference channel and generates a square wave for the synchronous demodulators in both the signal and reference channels.
Measurement Channel	Receive the 50 kHz measurement signal from the front end amplifier and generates a DC voltage that is applied to the ADC inputs.
Band pass filter	The output of the front end amplifier first passes through a band pass filter to reject noise and distortion.
Calibration Switch	An analog switch after the first bandpass filter, which selects either the measurement signal or a fixed calibration signal.
Switched gain amplifier	After the calibration switch, the signal passes through a switched gain stage. This allows the DSP to select one of four gains, each three times higher than the last.
Second band pass filter	After the switch gain stage is another bandpass filter, identical to the first DAC controlled gain amplifier. After the second bandpass filter, the signal passes through a DAC controlled gain stage. This allows the DSP to select gains in a useful range from 1 to 3 and with a resolution of about 1%.
Synchronous demodulator	Converts the 50 kHz sine wave signal to a different DC signal.
ADC input buffer	The ADC input buffer filters the output of the demodulator and drives the ADC inputs.
ADC Converter system	Includes the 18-bit stereo analog to digital converter (ADC) and extensive power supply conditioning filters. The transducer signal channel is connected to both inputs of the converter. The converter produces digitized sample of its input at a 31.25 kHz rate
Force Coil Driver	Applies a DSP controlled (18-bit DAC) current to the force coil. The magnetic field from the coil generates a controlled force pushing the stylus down onto the sample.

Table 1-1. *Descriptions of Figure 1-2, The MicroHead II Control Board Block Diagram (Continued)*

Function	Description
TV Camera	The MicroHead board provides 12 V power to the camera. The camera video can either loop through the MicroHead board and exit on the 50-wire ribbon cable, or go directly to the video overlay board via a coax cable.
Camera auto-iris/lamp driver	Some TV cameras (especially CCD cameras) do not have sufficient light level accommodation range built in. To handle this, the camera auto-iris output is used by this DSP controlled circuit to adjust the illumination lamp voltage to a level which allows proper camera operation. The board supports two independent lamps.
Drop & Zoom Motion System	The MicroHead board implements full DSP based motion control for the drop and zoom motors. Both motors have shaft encoders and home switches. The drop motor driver controls the stylus position via the stylus drop motor. When energized, the motor gently lowers the stylus arm into the measurement position. The zoom motor drives the zoom lens in the viewing optics. The drop motor driver has a special circuit which lifts the stylus whenever the power fails or the DSP software is not running.
Host Digital Interface	The 8-bit bus from the UPI card drives the host interface on the MicroHead card. An address register latches the address desired on the card, then the computer can read or write 8-bit data at that address. The host can directly communicate with only limited parts of the MicroHead board (most parts connect to the DSP). Directly accessible to the host are the calibration EEPROM, the ID register, two status registers, two FIFOs for passing messages back and forth to the DSP, and the host interface of the DSP itself.
Digital Signal Processor System	The heart of the MicroHead board is the DSP56002 Digital Signal Processor. The DSP has a 96 Kbyte bank of external memories for program and data storage. The DSP connects to the host data bus via its host interface, and also via two message passing fifos and a status register. The DSP connects to local resources via the main “Port A” address and data buses, and also through the “SSI” (synchronous serial interface) to the 18-bit ADC and DAC. Other resources attached to Port A include 2 bytes of status registers, 3 bytes of control registers, the 8-bit analog I/O chip used to control the lamp servo, and the shaft encoder decoders and PWM generators for the drop and zoom motors.
Calibration EEPROM	A 2 k x 8 k serial access EEPROM is provided to store calibration information about the head. Access to the EEPROM is provided by a 2-wire interface. The host computer software must generate both the data and clock signals in the proper format to access the EEPROM.

Table 1-1. *Descriptions of Figure 1-2, The MicroHead II Control Board Block Diagram (Continued)*

Function	Description
Status Lights	The status lights are three light emitting diodes (LED1-3) on the front edge of the board. These lights are controlled by the DSP through the DSP control register. When the DSP is in reset, the lights are all on. When the DSP software is running, it controls the function of the lights in software. The green led (LED3) is flashed at about 3.8Hz while the DSP code is running. This is the “all is well” indication for the DSP software. The yellow led (LED2) is the “above” light. It is turned on if the stylus is above null. The red led (LED1) is the “acquiring data” light. It is turned on if the host is acquiring measurement data by means of the TRIGGER* signal. When the DSP software encounters a fatal error, it branches to its fatal error handler and ignores all signals from the host system except reset. The fatal error handler flashes an error code on the status lights. The error code consists of a series of six flashes of the leds followed by a brief dark period, then repeating. For example, “r r r y g r” would be three red flashes, a yellow flash, a green flash, a red flash, and then no lights. This sequence repeats until the system is reset or switched off.
Proximity Detector	The proximity detector is an opto-electronic module which plugs into the MicroHead board. The Module detects most objects if they approach closer than about 5 mm to the face of the detector. The MicroHead board has a timing generator, an LED driver, and a receiver circuit to support the detector. The sensor is a Banner SP100FF “Fixed field Sensor”. The molded plastic module contains an infrared led emitter and two photo sensitive detectors. We chose not to use the interface module supplied by Banner for use with these sensors. The Banner module contains an oscillator which could potentially interfere with our LVDC electronics. It also is quite expensive. The resulting proximity detector performances is largely independent of sample reflectivity. It works equally well for a mirrored surface and for flat black surfaces. The most likely way to fool it is a transparent sample with a highly reflective back surface. The signal from the back surface can overwhelm the signal from the front surface, rendering it invisible.
Temperature Sensor	The MicroHead board provides a connector for attachment to a thermistor temperature sensor. The thermistor is connected to a reference voltage through a bias resistor, The resulting voltage is compared to the output of an 18-bit DAC by a comparator. The DSP uses this hardware to measure the thermistor voltage, and thus, the temperature.

Table 1-1. *Descriptions of Figure 1-2, The MicroHead II Control Board Block Diagram (Continued)*

Function	Description
Power Supplies	Filtering is provided for the +5 V, +15 V, -15 V, and +12 V supplies. The +15 V and -15 V supplies are used by regulators on the MicroHead board to generate the +8 V and the +5.1 V supplies used by the analog section of the MicroHead board.
DSP56002 digital signal processor	The Motorola DSP56002 digital signal processor (DSP) supports a 24-bit word size. This is a good fit with the 18-bit data generated by the CS5389 ADC. The DSP56002 host interface allows for convenient downloading of DSP software and eliminates the need for any EPROM program storage. The DSP56002 synchronous serial interface allows a simple connection to the serial interfaces of the high resolution digital audio ADC and DAC used. The DSP56002 operates with a 24 MHz clock. The 8 MHz clock coming into the board feeds into the DSP56002's phase lock loop. The phase lock loop can increase the clock rate by integer multiples of 8 MHz up to 40 MHz. You can observe the multiplied clock at test point TP21. On reset, the DSP uses the 8 MHz clock directly until the boot program initializes a higher clock rate. Currently, the boot program immediately sets the clock to 16 MHz, and the main DSP codes sets the clock to 24 MHz.
DSP External Peripheral Read Addresses	The DSP external peripherals are all located in the top 64 words of Y memory space to take advantage of the 56002's ability to add extra wait states for these addresses and to use the peripheral addressing mode.
DSP software boot process	The host interface is used in the DSP software booting process to download a secondary (Tencor written) boot routine. This initial download is controlled by Motorola's boot software located on board the DSP56002 in ROM. It is necessary to first download a more intelligent boot routine, then download the actual DSP operating software. Motorola's boot software can only load the first 512 words of P memory space.
Calibration EEPROM	A 2 k x 8 k serial access EEPROM (U33, an AT24C16 from Atmel) stores head calibration information. This memory is accessed in 8-bit blocks (by-8 memory) in spite of having only one data line. A 2-wire interface provides access to the EEPROM. The clock line is strictly an input to the chip. The data line is bi-directional. The EEPROM drives the data line with an open drain driver. The data live (EEPRMDIO) connects to an I/O pin of U29 (also programmed to be open drain). The computer software must generate both the data and clock signals in the proper format to access the EEPROM. See the AT24C16 data sheet for more information on the required format.

Stylus Null Position Detection

The Stylus Null Position Detection circuitry controls the Z elevator movement. When the center vane holding the stylus has dropped beyond the null position, the Z elevator is allowed to move downward responding to key command. When the center vane reaches the null position, represented by a lit yellow LED, or is above the null position, downward Z elevator movement is stopped.

The Stylus Null Position Detection circuitry is integrated into the signal channel of the LVDC. It detects when the potential between the two capacitor plates is equal, defining the null position. It is also used to detect whether the center vane is above or below the programmed null position.

Scanner Box Interface PC Assembly (P/N 231703)

This is an interface between the hardware components of the scanner portion of the Profiler, excluding the measurement head, to the Universal Profiler Interface card for computer/software control. The Scanner Box Interface card provides the following functions:

- Generates +/- 15 V to the DC to DC converter for the measurement head.
- Input ports for the Handler Shutter Door (optional on Handler equipped units), Interlock Switches, and Keylock.
- Connects the two 4-channel Motor Driver boards through a single communication cable to the UPI board for Measurement Stage motor control.
- On the P-10, P-11, and P-12 the SBI is located in the back, left compartment, directly behind the Y-guiderail and Y-drive motor. On the P-22, the SBI is located on the lower, left side of the instrument.

Power Driver Motherboard PC Assembly (P/N 241288)

The Power Driver Motherboard is the interface of the 4-channel Motor Driver cards to the X-Distribution card for motor power, encoder feedback response, and sensor response of the motion system.

The Power Driver Motherboard acts as a junction box for the signals between the Elevator assembly and Y-Drive assembly. This board also contains the vacuum monitor and control interface for instruments equipped with a Handler.

The Power Driver Motherboard is in the back left compartment directly behind the Y Guide Rail, and the Y Drive Motor on the P-10, P-11, and P-12 instruments. On the P-22, the motherboard is located on the lower, left side of the instrument.

X-Distribution PC Assembly (P/N 241440)

The X-Distribution card is a junction box providing signals between the Power Driver Motherboard and the DC motors, limit switches, home sensors, clutch, vacuum switch, and the Handler door switch on the X-Drive motion system and the motorized stage. This card is in the measurement chamber on top of the Y Guide Rail.

The Four-Channel Motor Driver PC Assembly (P/N 242392)

The 4-channel Motor Driver PC assembly amplifies the motor drive signals from the Universal Profiler Interface PC assembly. It also collects and distributes the feedback signals from the various drive motors and sensors to the Motor control and Measurement Interface PC Assemblies.

If the instrument is fitted with a motorized stage, with menu driven “theta” rotation and left to right “leveling” capabilities, there will be two 4-channel Motor Driver PC Assemblies, one per each Motor Control PC assembly.

The 4 Channel Motor Driver PC assemblies are located in the back of the instrument, in a compartment behind the “Y” drive motor for the P-10, P-11, and P-12. On the P-22, they are located on the lower, left side of the instrument.

The outer slot on the Power Driver Motherboard PC assembly is only for the one 4-channel Motor Driver PC assembly that drives the X-Slow, X-Fast, Y, and Z motion axis.

The inner slot is only for the second 4-channel Motor Driver PC assembly that drives the theta and level motors of the motorized stage. Two separate ribbon cables connect these cards to the Universal Profiler Interface card.

Motor Driver Amplification Circuitry

The 4-channel Motor Driver Amplification Circuitry amplifies the pulse width modulation (PWM) signal and provides a shunt to the transient feedback noise of the drive motors.

The On/Off switch of this motor drive circuitry connects to the Limit Switches and the computer emergency shutdown logic, monitored on the Universal Profiler Interface PC assembly (PSTIMEOUT line).

The Pulse Width Modulation and Sign signals connect the X-Distribution PC assembly to the assigned motors.

Encoders, Limit and Home Switches, Signal Feedback

The feedback signals from the motor encoders are received through the Power Driver Motherboard PC assembly and channeled to the 4 Channel Motor Driver PC assembly(s) and then on to the SBI board for transmission to the UPI board.

After receiving the motor encoder feedback signal, the signal goes to the Universal Profiler Interface PC assembly to monitor the position of the Motorized Stage (providing a close-loop motor control system).

The Universal Profiler Interface PC assembly uses X-Slow and X-Fast motor encoder signals to correlate the measurement scan rate to date sampling rate.

PC Boards

For more information, refer to your DOS/Windows manuals.

Disk Controller

The disk controller card accesses and transfers information from the hard and floppy disk drives. It is also provides I/O for the Printer and Serial communication interface. This is a third party vendor card.

Video Blaster

The Video Blaster card interfaces the video signal from the CCD camera with graphics information from the VGA card. This is a third party vendor card.

VGA

The VGA card generates graphics for the computer system. This is a third party vendor card.

IDE Hard Disk

The 850 Mbyte IDE hard disk stores the Profiler operating software and additional databases created from the software package.

2

TENCOR PROFILER INSTALLATION

This chapter explains the installation process for the Profilers.

Customer:	____________________	W. O. Number:	____________________
Unit Serial Number:	____________________	Software Version:	____________________
Measurement Head Assembly type (circle one):	SR	XR	MicroHead II
Date of Installation:	____________________	By:	____________________

Required Tools

To install the profiler, you need the following:

- VLSI Model SHS-9400, 9400 Å Step Height Standard, P/N 080128
- VLSI Model SHS-8.0, 8 µm Step Height Standard, P/N 080144
- VLSI Model SHS-24.0, 24 µm Step Height Standard, P/N 080152
- 50 mm 1/10th Wavelength Optical Flat, P/N 244643
- Set of Standard and Metric Allen wrenches
- Small slotted screwdriver (for trimpots)
- 7/16 in., 1/2 in., and 9/16 in. sockets, with 3/8 in. drive ratchet
- Clean room cloth
- Brayco 1624 lubricant, P/N 177555
- Large flat-blade screwdriver
- MicroHead Stylus Alignment Tool, P/N 219517

Pre-Power Checkout (P-10, P11, P12)

Verify the following items are with the instrument:

Windows:

- MS-DOS diskettes with User's Manual
- Windows diskettes with a User Guide
- One (1) set of Windows profiler software with a User Documentation Set

DOS:

- Print cache software package (DOS only)
- QEMM software package DOS only
- One (1) set of DOS profiler software with a User Documentation Set

To complete the pre-power checkout (P10, 11 and 12):

1. Visually inspect:
   a. The shipping crate
   b. The Shock Watch monitor label
   c. The Tip-n-Tell monitor label

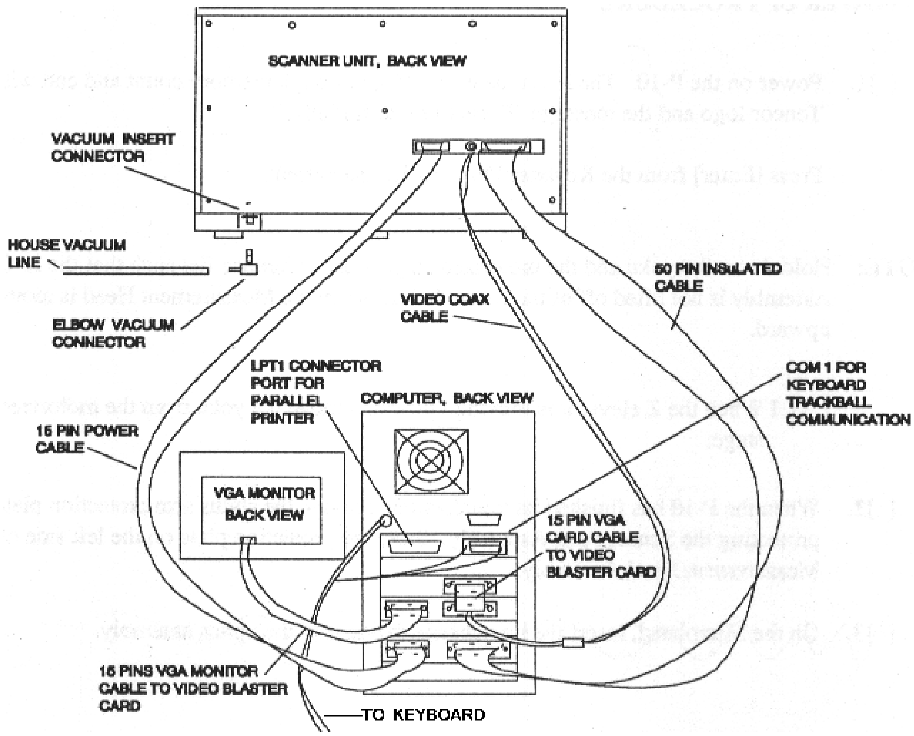
   If shipping damage is apparent, notify the customer and your supervisor.
2. Remove the one turnbuckle that holds the Measurement Head assembly in place.
3. Remove the computer cover and do the following:
   a. Check all PCB's, check for connection to the CPU motherboard backplane.
   b. Check all ribbon cables, their connectors, power cables, and ground lines. Insure that each is plugged tightly into their respective mating connectors.
4. Secure the computer case cover back onto the computer.

Note: *Cabling for the P-22 differs from the other profilers.*

5. Refer to Figure 2-1 on page 2-3, and connect the following:
   a. Connect the short interface cable from the Video Blaster card (labelled V Blaster 2) to the VGA card (labelled V Blaster 1).
   b. Connect the coax video cable from the Scanner Box Interface card (SBI) to the Video Blaster card interface connector.
   c. Connect the monitor signal cables to the computer Video Blaster card (labelled MONITOR).
   d. Connect the Monitor Power cable to the rear of the computer.
   e. Connect the 50-pin Scanner Data cable (P/N 240427) from the Universal Profiler Interface card (UPI) connector labelled Scanner Data to the Scanner Box Interface card.
   f. Connect the 15-pin round Scanner Power cable (P/N 406325) from the UPI card connector (labelled Scanner Power) to the SBI card.
   g. Connect the keyboard to the rear of the computer.
   h. Insert the vacuum fitting for the vacuum hose at the lower right rear of the instrument (for the P-22, this connection is on the lower, left side of the instrument).

i. Connect the computer power cord from the computer to the wall power outlet.

Figure 2-1. *Cable Connections (P-10, 11, 12)*



Pre-Power Checkout (P-22 only)

Verify the following items are with the instrument:

- MS-DOS diskettes with User’s Manual
- Windows diskettes with a User Guide
- One set of Windows profiler software with a User Documentation Set

To complete the pre-power checkout

1. Visually inspect:
   a. The shipping crate
   b. The Shock Watch monitor label
   c. The Tip-n-Tell monitor label

   If shipping damage is apparent, notify the customer and your supervisor.
2. Remove the left side panel.
3. Remove the one turnbuckle that holds the Measurement Head assembly in place.
4. Check all of the cable connections from the following points:
   a. The computer to the Scan Box Interface board.
   b. The Scan Box Interface to the Measurement Head
   c. The camera to the Pattern Recognition card.

5. Open the side panel. Remove the Isolation Table lock-down bolts. there should be one toward the back of the isolation table and two towards the front. The ones towards the front of the table can be removed from the front door.
6. To level the instrument, Place a level on the reference flat, adjust the instrument leveling feet.
7. Connect the air and the vacuum. Make sure that the isolation table is floating. When you push the table down, make sure it comes back up. Also, when you push the table sideways, it returns back to the center of the stage without rubbing against anything.

Power-up Procedure

WINDOWS

Power-On Sequence and Operation

1. Turn on the power to the instrument. The computer screen displays the memory test, boots DOS, then starts Windows.
2. Double-click on the Tencor directory to open the window.
3. Double-click on the Profiler icon to start the program.

   The instrument starts to initialize. All the axes move to their home positions. When the Z-axis starts to move up, hold the yoke end and the motorized stage down so that it does not lift up with the head (See Figure 2-2).
4. When the elevator moves upward and comes to a stop, remove the yoke from the motorized stage.
5. When the profiler finishes initialization, remove the stylus protection plate.

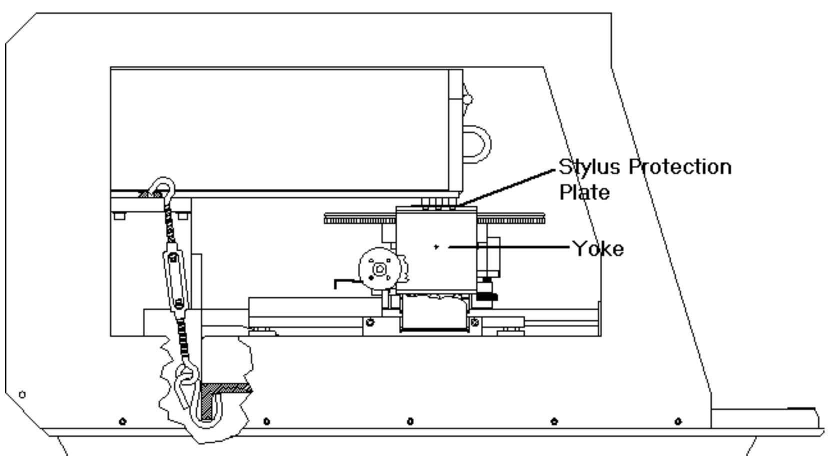
DOS

Power-On Sequence and Operation

The instrument does a memory count, boots DOS, displays the Tencor logo, and the **"Press Enter to Initialize"** message. Press ENTER at the keyboard to start the program.

1. The instrument initializes, all the motion axes move to their home positions. When the Z-axis moves upward, hold the stylus protection plate down to the yoke.

Figure 2-2. *Stylus Protection Plate and Yoke*



2. When the elevator moves upward and comes to a stop, remove the yoke from the motorized stage.
3. When the profiler finishes initialization, remove the stylus protection plate that protects the Sensor Arm assembly.

Power-On Sequence and Operation

DOS

When you start or reset the instrument, the profiler displays an initialization screen, which shows the following:

- Software options installed into instrument
- The instrument serial number

Note: *If you press any other key other than* ENTER*, the instrument exits to DOS.*

WINDOWS

When you press the **Enter** key, double click on the profiler icon and the instrument initializes, runs a self-diagnostic routine, and sends all motorized components to home. The homing sequence of individual axis are, as follows:

- The elevator moves upward until it trips its magnetic home switch.
- The X-axis of the motorized stage moves toward the center of the reference flat in the X direction and stops when its home flag on the X-carriage assembly trips the X home optical switch sensor.
- The Y-axis of the motorized stage moves toward the center of the reference flat in the Y direction and stops when it trips its magnetic home switch.
- The Theta motion of the motorized stage rotates and trips its magnetic home switch to establish its home position.
- The Level motion of the motorized stage tilts right to left to establish home through the motor encoder counts process.

Should an axis fail to home, the profiler displays an error message on the monitor.

Power Supply Checkout

The voltage supply levels of the Power Supply in the computer are not adjustable. Measure the following DC voltage levels at the Scanner Box interface card.

Wire Color at J17	Test Point (TP)	Voltage	Measured
Black	7, 2	Digital GND	
Red	11	+5 V	______
Yellow	6	+12 V	______
Orange	20	-12 V	______
Black	8	Motor GND	
Yellow	9	Motor +12 V	______
	3	-15 V	______
	4	+15 V	______

Stylus Force Calibration

Windows **To update the parameters in Windows:**

1. Raise the Measurement Head assembly.
2. Go to the Top Level menu.
3. Go to the Calibration menu.
4. Choose Stylus Force.
5. Go to the Stylus menu and select the following:
   a. Raise.
   b. Calibrate Force Coefficients.

DOS **To update the parameters in DOS:**

1. Raise the Measurement Head assembly.
2. Choose the Stylus Force menu, from the Calib menu, and press the **Enter** key.
   The stylus force Params menu appears.
3. Press the **F1** key to calibrate, and press ENTER.
4. Press the **F4** key to save the sample reading of the Sensor Arm assembly and return to the main menu.

Stage Tilt (Front to Back)

The front and back Z-coordinates should be within 20 µm of each other. If the difference between the front and back values is greater than 20 µm, adjust the stage tilt and repeat these steps.

Note: *If you click a second time on the* **Focus** *button the elevator stops moving downward.*

Be sure that there is a test sample underneath the measurement head before clicking on the **Focus** button, otherwise a head crash can occur.

To adjust the stage tilt from the XY View window, do the following:

1. Move the measurement stage, as follows:
   a. Click on the direction control buttons in the tool bar to move the stage forward.
   b. Click on the **Focus** button in the tool bar to null the stylus on the front portion of the measurement stage.

   CAUTION: Before you click on the Focus button, make sure there is a test sample underneath the stylus head (otherwise you damage the stylus).

   c. Record the Z-coordinate.
2. Position the measurement stage to have the stylus null at the back portion of the stage.
3. Re-null the stylus.
4. Record the Z-coordinate.
5. If the Z-coordinate from the front and the back is larger than 20 microns, then loosen the clamp for the tilt adjustment screw near the bottom front of the motorized stage. Turn the knob counter-clockwise to raise the front of the stage (decrease the Z-coordinate value).
6. Repeat step 1 through 5 until the Z-coordinate values between the front and back are within 20 microns.

Check Zoom Drift

To check zoom drift

1. Place a VLSI standard on the Measurement Stage.
2. Position the Measurement Stage so the cross hair is shown on the monitor screen aligned to any intersecting perpendicular lines of the standard at maximum zoom.
3. Press the **Zoom** key.
4. Use the **up** and **down arrow** keys to run the optical zoom between its maximum and minimum limits.
5. Record the image drift of the intersecting perpendicular lines.
6. If the drift exceeds 0.25", realign the optics and/or camera.

Checking MicroHead Noise

During testing, the MicroHead scan may fail due to static and/or dirt on your test sample. A static charge affects the performance and calibration of the instrument. If you clean the test sample with a dry clean-room cloth, you create the static charge.

If you discover that the Sensor Arm assembly is statically charged, repeat the instructions below.

To remove the static charge and dirt

1. Tilt the test sample at an angle and flush with methanol.
2. Flush the test sample a second time with D.I. water.
3. Let the test sample air-dry.

CAUTION: Do not clean or dry the test sample with a clean room cloth. Let it air-dry.

Windows

To check for noise using Windows

1. Access the Recipe Editor window:
   a. From the Top Level menu, select Scan.
   b. Select View/Modify from the Recipe menu.

Note: *If the scan fails, there may be static on your test sample. Follow the proceeding instructions to remove the static.*

2. Set the following parameters:
   - *Recipe* for 10-s scan
   - *Stylus force* to the Measurement Head used (MicroHead to 2 mg)
   - *V.Range/Res.* to the most sensitive range.
   - *Sampling rate* 50 Hz.
3. Select Diagnostic from the Recipe menu.
4. In the Diagnostic window, enable the No-Motion Scan parameter.

   Leave all other parameters disabled.
5. Click on OK.

   This activates the diagnostic scan parameters for all the upcoming scans until you disable the No-Motion Scan parameter.
6. In the XY View window, null the stylus on top of the optical flat and take a scan.
7. Set the following parameters:
   - *Recipe* for 100-s scan
   - *Stylus Force* to the Measurement Head used (MicroHead to 2 mg)
   - *V.Range/Res.* to the most sensitive range.
   - *Sampling rate* 50 Hz.

Record the TIR reading for the 10-s scan, and repeat for the 100-s scan (report form shown on the previous page).

DOS **To check for noise using DOS:**

1. Null the stylus on the Optical Flat.
2. Press the **Menu** key to access the menu screen.
3. Set the following parameters (Recipe menu, View | Modify):
   - *Recipe* for 10-s scan
   - *Stylus force* to the Measurement Head used (MicroHead to 2 mg)
   - *V.Range/Res.* to the most sensitive range.
   - *Sampling rate* 50 Hz.
4. Press the **F4** key to access the menu screen.
5. From the Diag menu, select Scan and press **Enter**.
6. Press **F2** to take a “No-Motion with Null” scan.
7. Record the data.
8. Press the **Menu** key to access the menu screen.
9. Set the following parameters (Recipe menu, View | Modify):
   - *Recipe* for 100-s scan
   - *Stylus Force* to the Measurement Head used (MicroHead to 2 mg)
   - *V.Range/Res.* to the most sensitive range.
   - *Sampling rate* 50 Hz.
10. Press the **F4** key to access the menu screen.
11. From the Diag menu, select Scan and press **Enter**.
12. Press **F2** to take a “No-Motion with Null” scan.
13. Record the data.
14. If the Sensor Arm assembly is statically affected, perform stylus force calibration.

Record the TIR reading for the 10-s scan, and repeat for the 100-s scan

	10-Second Scan		100-Second Scan	
Stylus Force	**TIR**	**Spec**	**TIR**	**Spec**
2 mg	________	60 Å	________	150 Å

If environment is noisy, write cause: ____________________

____

____

____

Scan Noise Measurements

Use the Optical Flat as the measurement sample, and set the “Recipe” to the following parameters (all noise measurements are taken at the 50Hz sampling rate set in the “Recipe”):

In windows, verify that “No-Motion Scan Parameter” from the Diagnostic menu is disabled.

Note: *Remove stylus force for standard head*

Scan Length/Speed	Stylus Force	Measured	Spec	Range/Res.
30 mm @ 2mm/s	5 mg	________	300 Å	130/1
400 µm @ 50 µm/s	2 mg	________	100 Å	6.5/.5
25 µm @ 1 µm/s	2 mg	________	100 Å	6.5/.5

If the measured TIR is greater than the specification, polish the Reference Flat with a clean-room cloth, and/or check for bending of the piano wires on the X-Drive assembly. If the piano wires are properly set, make adjustments to the stage bindings, and blue turcite pads on the X-Carriage assembly.

Step Height Calibration

DOS **To check the calibration for high and low range measurements**

1. Use the default files, _STEPHTH for Mid and High Range (use vertical Range noted in Table 2-1) and _STEPHTL for low range or you can set the Recipe with the parameters shown in Table 2-1 below:

Table 2-1. *Step Height Calibration Recipe for DOS*

	MicroHead II Ranges	
Parameters	Low	Mid and High
Menu	Calib13	Calib300
Scan Length	360 µm	1500 µm
Scan Speed	20 µm / s	100 µm / s
Total Scan Time	18 s	15 s
Sample Rate	50 Hz	50 Hz
V. Range/Res.	(+/-)3.25 µm / 0.5 Å	26 µm and 130 µm
Stylus Force	2 mg	2 mg
Multi-Scan Ave.	2	2

2. For High and Mid range: Use an 8 µm VLSI step height standard to record the following measurement rate:

	Stated Value	Measured Value	% Difference
Mid Range	________	________	________
High Range	________	________	________

The measured value in the Mid and High range should be within 0.5% of each other.

If the difference in the High Range is greater than 2% of the stated value of the steo height standard, adjust the Factor Calib parameter in the Head Setup menu.

If the measured value is greater than 3% of the stated value, use DCON to perform hardware calibration. Check the Linearity table for the 0.5% linearity throughout the Sensor Arm assembly vertical range (refer to Chapter 6, *Linearity Adjustments*).

3. For Low range: Use an VLSI step height standard between 4,000 Å to 10,000 Å and record the following:

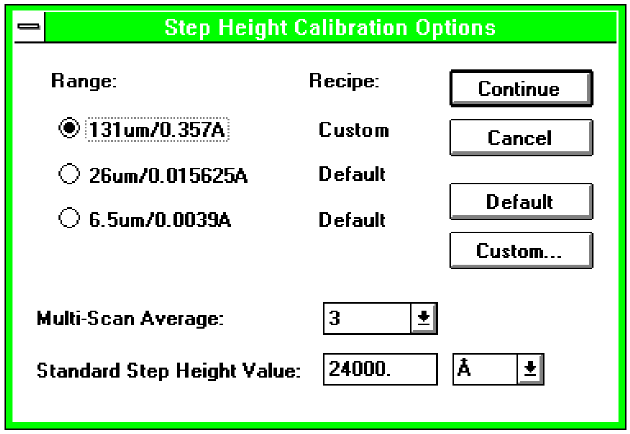
Stated Value	Measured Value	% Difference
________	________	________

To perform the Step Height Calibration

1. Click on the **Step Height Calibration** button in the Scan Calibrations window.

   The Step Height Calibration Options dialog box appears:

Figure 2-3. *Step Height Calibration Options Dialog Box*



2. *Range*: Select the calibration range appropriate for the step height standard you are using and click on its radio button.
3. *Multi-Scan Average*: Choose a value for Multi-Scan Average by clicking on the drop-down button and selecting from the list. This number determines how many times the profiler will repeat the scan. Results from each scan are automatically averaged.
4. *Standard Step Height Value:* Enter the nominal step height of the standard you are using into the Standard Step Height Value field, and select the correct units from those available in the drop-down list to the right.

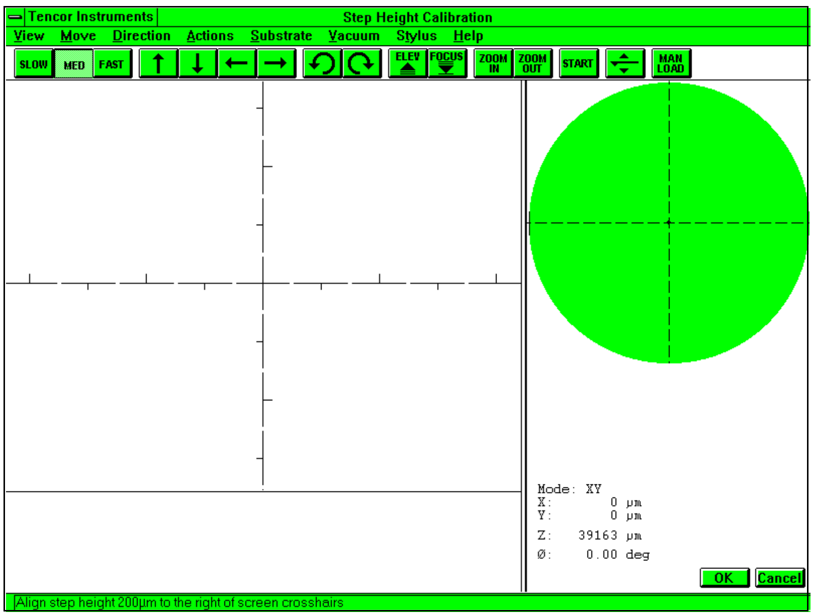
5. Recipe:

   The profiler provides both default and customizable calibration recipes for each of the three ranges. The recipe that will automatically be applied—default or custom—is indicated to the right of the range. (Custom calibration filenames are preceded by an underscore, for example, _STEPHTH is the filename for custom step height recipes.)

   - To use the recipe indicated to the right of the range, click on the **Continue** button to proceed with the calibration.
   - To apply the default recipe when “custom” is indicated, click on Default. The message, **“Copy default to custom recipe?”** appears. Clicking on yes replaces the parameters in the custom recipe with default values.
   - To apply a custom recipe when “default” is indicated or when you want to modify the custom recipe that is indicated, click on Custom... The Recipe Editor opens, displaying the parameters for the custom recipe. Make changes as desired and proceed as if taking a scan.

   The Step Height Calibration window appears.

Figure 2-4. *Step Height Calibration Window*

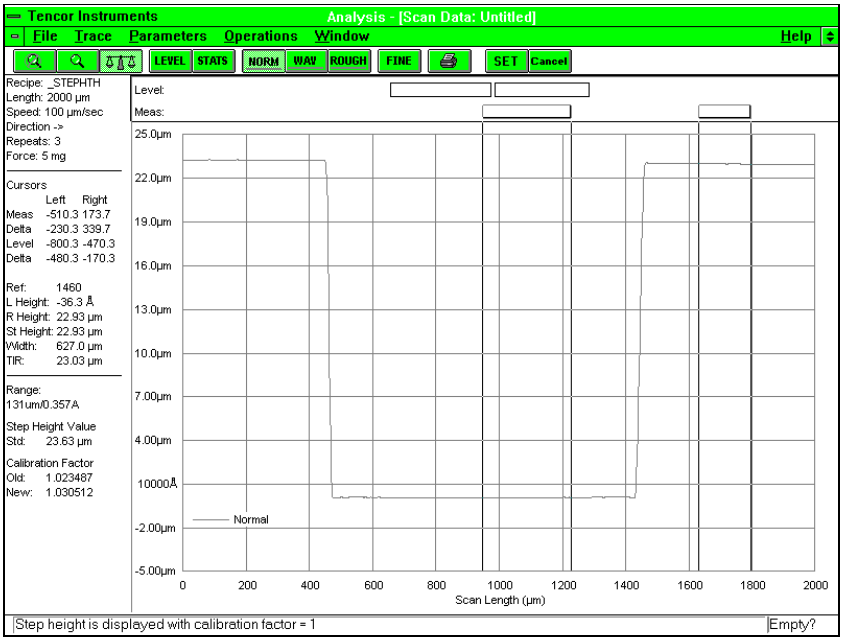


6. Locate the calibration step on the standard, just as you would position any other sample for scanning.
7. Position the cross hairs about 200 µm from the right side of the step height and click on **OK** or on the **Start** button in the tool bar.

   The instrument performs as many scans as you indicated in Step 3. Upon completion, the calibration factor is calculated and shown at the bottom of the Information Area of the Data Analysis window (Figure 2-5).

Note: *Some versions only display a Step Height Calibration result window.*

Figure 2-5. *Step Height Calibration Data Analysis window*



8. Click on Set button in the tool bar to save the calibration factor, or the Cancel button to keep the original value and return to the Scan Calibrations window.

Scan Length Accuracy

If the error is much greater than the specifications, the motor encoder/reader may need to be replaced.

Use the 9,400 Å VLSI standard, and do the following:

1. Take a 6 mm @ 0.40 mm/s scan across the large measurement square in the lower left corner, measure and record the length of the large measurement square:

   Length: ________________ Spec: 4400 µm +/- 90 µm

2. Take a scan of 500 µm @ 10 µm/s across the 2 Ω pitch grid and record the length of 15 full cycles:

   Length: ________________ Spec: 300 µm +/- 10 µm

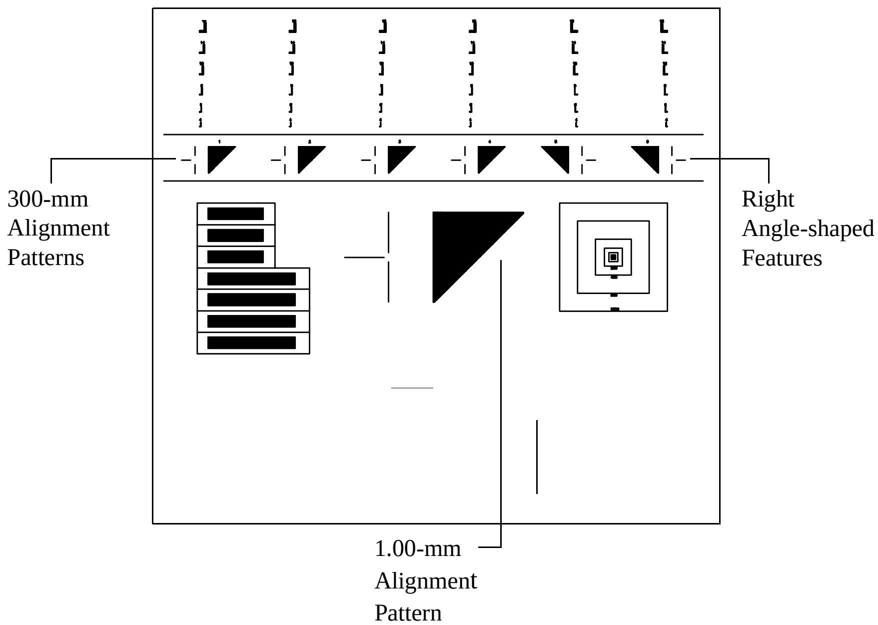
Scan Position Offset Calibration

Use the Tencor Stylus Alignment Tool (Tencor Part No. 219517) to determine the distance that the stylus tip is offset from the cross-hairs overlay in the XY View window.

Perform the stylus offset calibration

- whenever you change the stylus, or
- if you change zoom settings in order to scan a small feature.

Figure 2-6. *Tencor Stylus Alignment Tool*

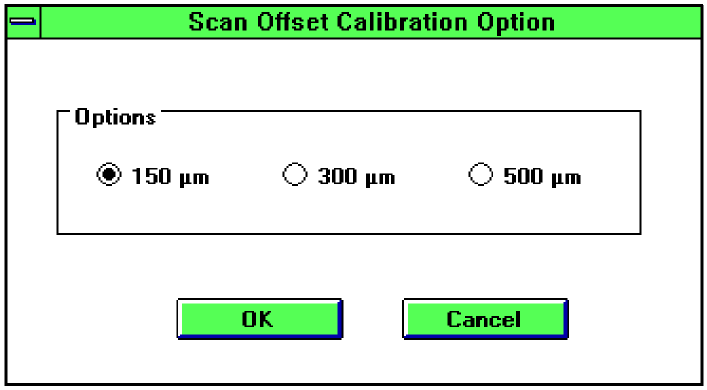


IMPORTANT: Before performing the Scan Position Offset calibration, make sure the Optical Magnification is at the same setting that the scan will be taken. Note that while the scan takes place at high magnification, the stylus completely blocks the field of view.

To calibrate the Scan Position Offset (Windows)

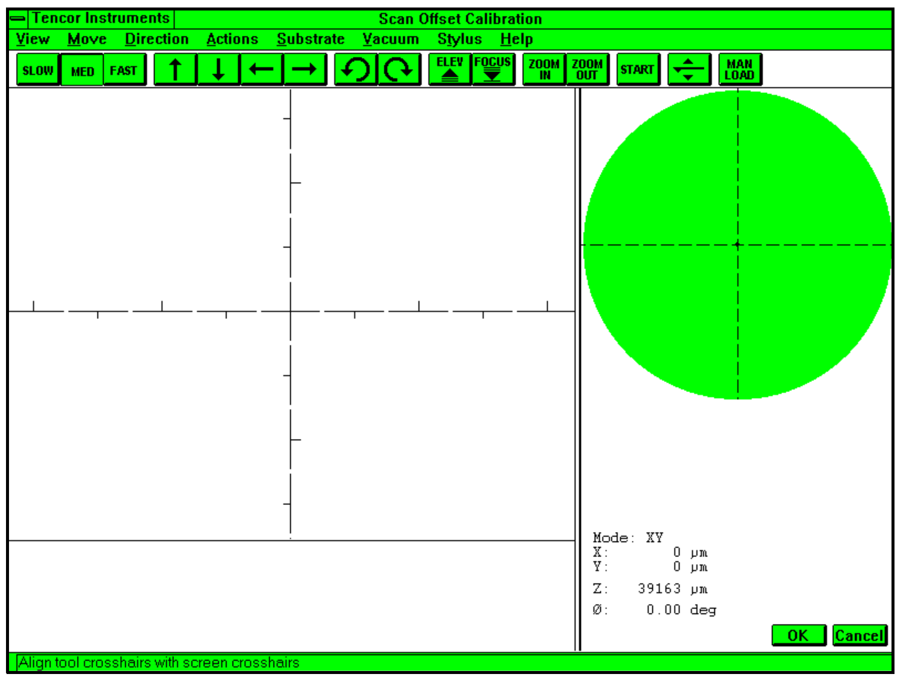
1. Load the Stylus Alignment Tool in the instrument so that the alignment patterns are square to the stage X- and Y-axes.
2. Turn on the vacuum.
3. Click on the Scan Position Offset Calibration control button in the Scan Calibrations window.
4. The Scan Position Offset Calibration Options dialog box (Figure 2-7) appears in the center of the window:

Figure 2-7. *Scan Position Offset Calibration Options Dialog Box*



5. Click on the radio button next to 150 µm to select the 150 µm calibration option.
6. Click on **Continue** to proceed. The Scan Position Offset Calibration window appears:

Figure 2-8. *Scan Position Offset Calibration Window*



7. Click on Focus in the XY View tool bar to lower the measurement head until the sample surface is visible and the stylus nulls on the surface.
8. Locate one of the 150-µm cross-hairs alignment patterns (Figure 2-9)

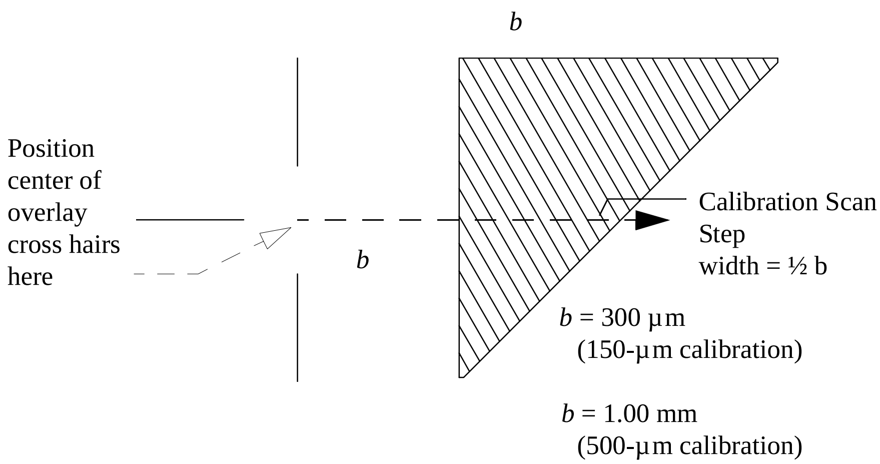
   There are two different-sized alignment patterns for the Scan Offset Calibration on the Stylus Alignment Tool (see Figure 2-6). Both have right triangles with two equal sides; one has 300-µm sides (for the 150-µm calibration option), the other has 1.00-mm sides (500-µm calibration option). There are six of the smaller patterns, and one of the larger.

Use one of the 300-μm patterns with the 150-μm calibration first. If the stylus offset is too great, the calibration scan will miss the triangle. In that case, try the 1.00-mm pattern using the 500-μm calibration option, then repeat the 150-μm calibration.

If the calibration scan misses the 1.00-mm triangle, the stylus needs to be physically realigned by an authorized Tencor Instruments service representative.

9. Align the cross hairs of the video overlay with those of the pattern so that center matches center, producing a trace path as illustrated by the dotted line in Figure 2-9.

Figure 2-9. *Cross Hairs Alignment Pattern*



Note: *If precision alignment for sequence operation (features ≤ 10 mm) is required, the optical magnification must be at maximum zoom, and the Video Calibration must be performed, or the Scan Offset Calibration cannot be accurate.*

10. Click on the Start button in the tool bar. The stylus lowers and the instrument scans the triangle at the point where the step width equals half the length of the sides—150 µm for the 300-µm triangle and 500 µm for the 1.00-mm triangle.

    When the scan is completed a message box appears.

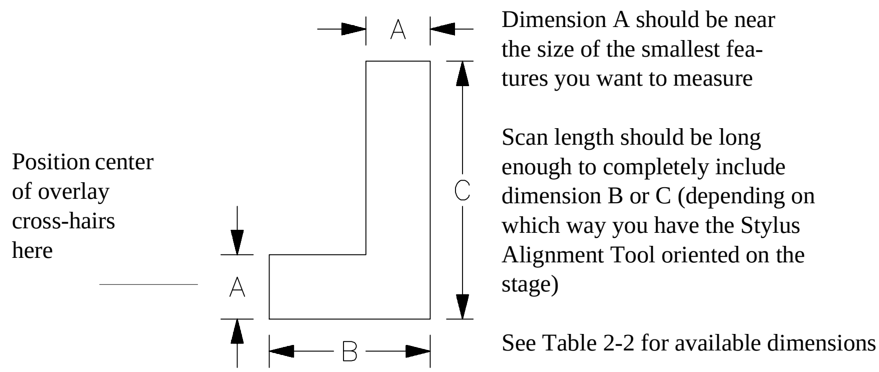
11. *If the values for Distance to Leading Edge and Step Width are within 2 µm of their "Should Be" values*, click on Cancel to keep the existing offset values.

    If the distance and width values are more than 2 µm from their "Should Be" values, but still relatively close, click on OK to accept the new offset calculation. Then repeat the scan until the distance and width values fall within the 2-µm acceptable range.

    If the distance and width values are substantially different, the current offset is too great to allow recalibration using the 150-µm calibration option. Click on Cancel and return to step 3. In Step 5, choose the 500-µm calibration option and repeat the scan on the 1.00-mm alignment pattern.

Note that it is difficult to verify the accuracy in the Y dimension. Therefore, it is a good idea to check your calibration before proceeding to scan samples. The Stylus Alignment Tool provides a set of right-angle-shaped features (Figure 2-10) of varying dimensions that are useful for checking the calibration. Use the feature that has dimensions on the order of the smallest features you intend to measure

Figure 2-10. *Right-Angle-Shaped Feature*



Windows

To check the Scan Offset Calibration:

1. Locate one of the right-angle-shaped features (Figure 2-10) with the center of the cross hairs and perform a scan (see Table 2-2 for available dimensions). The scan length you choose should allow you to completely scan across the feature.
2. If the stylus sets down above or below the bottom of the L, the calibration should be redone. (If above, the step width is approximately A instead of B; if below, no step appears).

Table 2-2. *Available Dimensions for Figure 2-10*

A (μm)	B (μm)	C (μm)
4	16	50
6	24	60
8	32	80
10	40	100
14	56	100
18	72	100

Scan Position Offset Calibration (DOS)

The first section explains creating the Recipe for calibration and is followed by the Calibration procedures. The next page explains how to calibrate the scan position off-set.

To create a Recipe:

1. Set the Recipe parameters to one of the following:
   - Select 150X150 Cal.
   - Select 500X500 Cal.
   - Create the recipe:

Items	**Settings**	
Horizon Units	Metric	
Scan Length	500 µm	
Scan Speed/Time	10 µm / s 30 s	
Samp.Rate/Hot.Res	50 Hz / 0.20 µm	
Surface Parameters	View	
Stylus Force	5 mg	
Contact Speed	3	
Profile Type	Centered	
V.Range/Resolution	(most sensitive)	
V.Display Scale	Auto	
Cursors (RELATIVE)	**Left (µm)**	**Right (µm)**
Measurement	-75.00	25.0
Level	-75.00	425
Delta Meas Width	0.00	0.00
Delta Level Width	25.0	25.0
Direction	→	
Multi-Scan Avg.	1	
Segmented	No	

2. Set the Surface Parameters to the following:

Surface Analysis

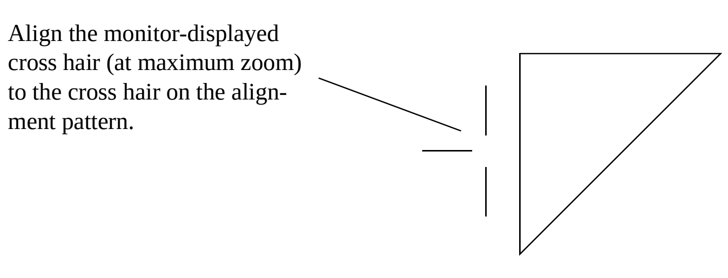
V. Units	Metric
Graph	Raw Data
Long Wave Cutoff	Off
Short Wave Cutoff	Default
Fit & Level	Off
Edge Distance to Edge	Display
StpWd Width of Step	Display

3. Set all other parameters to “Off.”
4. Press the **Menu** key to access the Main menu.
5. Choose Edge Factor from the Calib menu, and press the **Enter** key.
6. Set *Feature Detection* to Up Edge.
7. Set the *Slope Threshold* to 10.
8. Set the *Plateau/Apex Threshold* to 10.
9. Press the **F3** key to save the settings.

To calibrate the Scan Position Offset:

1. Place the Stylus Calibration Standard onto the measurement stage and enable the vacuum to hold it in position.
2. Choose Recipe from the Catalog from the main menu.
3. Select the “150X150_CAL” recipe and press the **Enter** key.
4. Lower the Measurement Head to the Stylus Calibration Standard.
5. Null the stylus and align the crosshair to the standard’s pattern (the smaller of the two triangular patterns).

Figure 2-11. *Crosshair Alignment Pattern*



6. Toggle the **up arrow** key to lift the stylus without moving the Measurement Head upward.
7. Align the monitor-displayed cross hair to that of the Alignment pattern of the standard in “Precision Mode” and in maximum zoom.

8. Press the **Z-0** key or the **X-Y** to access “Precision Mode,” and press the **F1** key until the screen displays the “Precision Mode” message.
9. Press the **X-Y** key to transfer the commands of the arrow keys for the X - Y stage control.
10. Press the up, down, left, or right arrow keys to activate the backlash removal shake.
11. Use the arrow keys to re-align the cross hair to the alignment pattern.
12. Press the **Start** key.

    The instrument scans the triangular feature to the right of the alignment pattern.

    When the scan is complete, the *Edge* and *StdWd* readings in the data screen should be 150 µm.

    If this measurement is off by more than 2 µm, do the following:

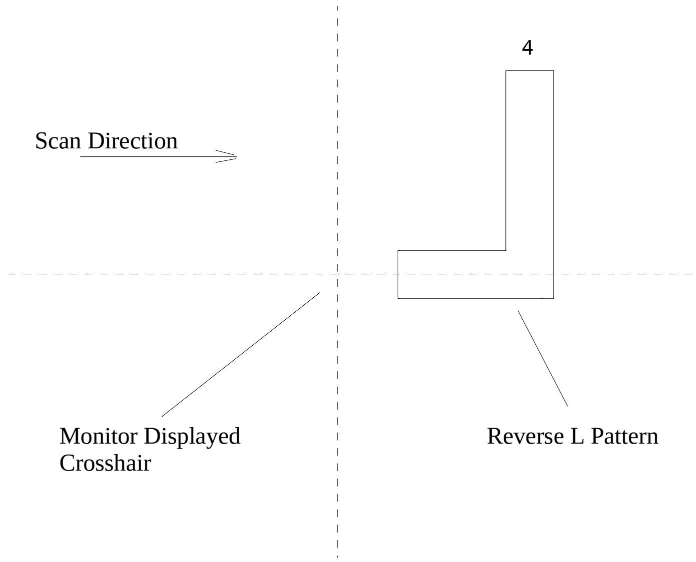
    a. Press the **Menu** key.
    b. Choose “Stage” from the “Config” menu and press the **Enter** key.
    c. Use the **up** or **down arrow keys** to highlight the “Scan Position Offset” parameter.
    d. Press the **F1** key (Learn position).

       The Stylus Offset Calibration submenu is displayed.
    e. Under the “Should be:” measurement on the calibration standard, enter 150 (for the 300 µm triangle pattern, the smaller triangle, or 500 (for the 1.0 mm triangle pattern, the large triangle).

       (If you use the 1.0 mm triangle, set the Recipe “Scan Length” parameter to 1.5 mm.)
    f. Press the **F2** key to save the taught value.
    g. Repeat these steps (from a-g) and verify the measurement stays within 2 µm.
13. Press the **Z-0** key to access the video mode.
14. Locate the reverse “L” shape pattern with the “4” label.

15. Align the monitor displayed cross hair in front at center of the leading edge of the reverse “L” shape pattern (refer to Figure 2-12).

Figure 2-12. *Reverse “L” Pattern*



16. Null the stylus at the targeted position shown above.
17. Press the **Start** key to take a scan.

The measured width of the horizontal portion of the “L” shape pattern should be 16 µm.

If the stylus misses the horizontal portion of the “L” shape pattern, repeat this section, steps 1 through 17.

3

HARDWARE MAINTENANCE (DOS)

Also refer to Appendix A, *Preventative Maintenance Schedule*.

Tencor profiler Preventative Maintenance/Post Repair Checklist

Customer:	________________	Phone Number:	________________
Unit Serial Number:	________________	W.O. Number:	________________
Date of P. M. /P. R.:	________________	Service Engineer:	________________

Required Tools

The following are required to maintain the profiler:

- VLSI Model SHS-9400, 9400 Å Step Height Standard, P/N 080128
- VLSI Model SHS-8.0, 8µm Step Height Standard, P/N 080144
- VLSI Model SHS-24.0, 24µm Step Height Standard, P/N 080152
- 50mm 1/10 Wavelength Optical Flat, P/N 244643
- Profiler Diagnostic Diskette
- Set of standard and metric Allen wrenches
- Tri-Flow lubricant, P/N 069213
- Clean room cloth
- MicroHead Stylus Alignment Tool, P/N 219517
- Brayco, 1624 lubricant, P/N 177555

Visual Inspection

Visually inspect the following

- Fraying of ribbon cables and wires.
- Confirm each connection is intact and contacts are good.
- Wiggle all ribbon cables and wires.
- Look for discoloration of the PCBs.
- Note each instance for possible future failure.
- On the X-Driver assembly, check that the Piano Wires are not bent or under strain. These absorb the stage and motor movement vibration.

Power Supply Inspection

The voltage supply levels of the Power Supply in the computer are not adjustable.

To check the DC voltage levels

Measure the following DC voltage levels at the Scanner Box Interface card:

Test Point (TP)	Voltage	Measured
2 and 7	Digital GND	**None**
11	+5 V	
6	+12 V	
10	-12 V	
8	Motor GND	**None**
9	Motor +12 V	
3	-15 V	
4	+15 V	

Mechanical Operation

To test mechanical operation

1. Set the Contact Speed in the Recipe menu to 3 and *Stylus Force* to 5 mg.
2. Toggle the **Z** key and press the **down arrow** key.
3. Watch the Sensor Arm assembly for one smooth, continuous, slow descent.

   If it fails, try changing the *Stylus Drop Timer* parameter in the Head Setup menu. If this also fails, adjust the Sensor Arm Drop Motor Tension Spring.
4. Lower the Sensor Arm assembly.
5. Go to the Calib menu, and select Stylus Force to perform a Stylus force Calibration.
6. Perform "plot response" of the Stylus Force Response Curve by choosing F1:Test from the Stylus Force Test Choices menu.
7. Perform alignment so the Sensor Arm assembly operates at maximum effectiveness.

Stylus Tip Check

Check the quality of the Stylus Tip by measuring over the “V” test pattern of the VLSI Step Height Standard. If the Stylus Tip is chipped on a side, or the point is missing, replace the stylus.

Cleaning and Lubrication

To clean and lubricate

1. With a clean-room cloth, clean and wipe off any excess lubrication from the X-Drive lead screw and the Y lead screw that may have built up.
2. Re-lubricate the X and Y lead screws with Brayco lubricant.
3. Execute the BURNIN program to exercise the measurement stage on the two lead screws.
4. Run the MOTTEST program and check if the measured PWM of both the X and Y motion axis is operating at around 80%.
5. Remove the Table Top from the motorized stage.
6. Remove the motorized stage from the X-Drive assembly.
7. Clean and lubricate the lead screw to the Theta and Level mechanism assemblies.
8. With a clean-room cloth, wipe clean the X-Guide Rail and the X-Guide Bars on the X-Drive assembly.
9. With a clean-room cloth, wipe clean the Profiler’s Reference Flat.
10. Lubricate the Reference Flat with 5-6 drops of Tri-Flow.
11. Spread the Tri-Flow with the clean-room cloth in a circular motion.
12. Remove any excess lubrication from the Reference Flat.
13. Wipe clean and polish the Reference Flat with a clean-room cloth.

    Excess lubrication will result in high scan trace noise.

Scan Noise Calibration Check

To check scan noise calibration

1. Use the 1/10 wavelength Optical Flat, null the Sensor Arm assembly on the flat and measure the environment noise by taking a no motion scan at the specified stylus force and scan time. Record the measurements:

	TIR Value	**TIR Value**
Stylus Force	**10 s (Spec)**	**100 s (Spec)**
2 mg	_______ < 60 Å	_______ < 150 Å

Note: *The noise reading recorded from the No-Motion scan provides the minimum noise baseline achievable based on the instrument capability and the controlling environment.*

If the TIR value exceeds the specifications shown, possible causes are:

- Laminar flow
- Environment noise
- Problem with the Measurement Head

2. Using the 1/10 wavelength optical flat, check the following scans.

Scan Length/Rate	Stylus Force	Direction	Spec	TIR
30 mm @ 2 mm/s	5 mg	→	300 Å	________
		←		________
500 µm @ 50 µm/s	2 mg	→	100 Å	________
		←		________
25 µm @ 1 µm/s	2 mg	→	100 Å	________
		←		________

If the TIR values recorded exceed the written spec, adjustment of the tension on the turcite pads connecting the X-Carriage assembly to the X-Guide Rail may fix the problem. If the problem is environmental, notify the customer of your findings.

Step Height Check

To check the calibration for high and low range measurements, set the Recipe to the following parameters:

Parameters	Low Range	Mid Range	High Range
Scan Length	300 µm	1500 µm	1500 µm
Scan Speed	20 µm / s	100 µm / s	100 µm / s
Total Scan Time	18 s	15 s	15 s
Sampling Rate	50 Hz	50 Hz	50 Hz

Stylus Force	2 mg	2 mg	2 mg
Profile Type	Center	Center	Center
V. Range/Res.	6.5 µm/0.5Å	26 µm/2Å	130 µm/10Å
Multi-Scan Ave.	2	2	2

For High Range: Use a VLSI thick film step height standard between 8 µm to 25.00 µm and record the following:

Stated Value	Measured Value	% Difference
__________________	__________________	__________________

If the difference is greater than 2% of the stated value, perform hardware calibration. If hardware calibration using DCON was done, check the Linearity Table for the 0.5% spec of the 300 µm vertical travel range of the LVDC.

For Mid Range: Use a VLSI thick film step height standard between 8 µm to 25.00 µm and record the following:

Stated Value	Measured Value	% Difference
__________________	__________________	__________________

If the difference is greater than 2% of the stated value, perform hardware calibration. If hardware calibration using DCON was done, check the Linearity Table for the 0.5% spec of the 300 µm vertical travel range of the LVDC.

3. For Low Range: Use a VLSI step height standard between 4,000 Å and 10,000Å, record the following:

Stated Value	Measured Value	% Difference
__________________	__________________	__________________

If the difference is greater than 2% of the stated value, perform hardware calibration.

Scan Length Accuracy

Use the 9400 Å step height standard to take a 6 mm @ 0.20 mm/s scan across the large measurement square in the lower left hand corner. Measure and record the length of the large measurement square:

Length ________________ **Spec: 4400** µm **+/- 90** µm

If the specification is not met, check for possible problems with encoder readers on the X-Drive assembly.

Step Height Repeatability

Use the 9400 Å step height standard to measure the step height 25 times at the same location using a Sequence scan.

When creating a Recipe, use the "Delta Width" measurement cursor to record an average readout of the stepheight. The Standard Deviation of these 25 scans should be within 10 Å of each other (in a controlled environment).

Computer Check

To check the computer

1. Check the Database for possible corruption by executing **Checkdb.bat** program (DOS software only). From the Tencor directory enter **Checkdb**.
2. Check the total memory space available on the Hard Disk by accessing Config from the Disk Path menu and press the **F2** (info) key. If it is 90% full, corruption of the database is likely. Notify the customer.

   When the Hard Disk if filled to 90% of its capacity, backup the database on diskettes/tape and purge the database from the Hard Disk. The backup database records can be viewed in the Profiler Off-line software package, or it can be restored back into the Profiler for review. For more information on the Profiler Off-line software package, contact the Tencor Sales/Marketing Department.
3. Check the Hard Disk for bad clusters and repair them with the DOS command SCANDISK.
4. Use QAPLUS or CHECKIT computer diagnostic program to analyze the system board and RAM memory.

4

HARDWARE MAINTENANCE (WINDOWS)

This chapter explains procedures under Windows 3.11.

Service Information

The Tencor Instruments Service Organization is available to you in the United States, Europe, and Japan. We also have representatives in Taiwan, Thailand, Israel, India, Brazil, Singapore, and Korea.

Our commitment is to provide a technical response by telephone within 24 hours, often within the same business day. Our commitment for on-site repair is 48 hours.

In the United States we handle all service requests through a central number located in California. Call (800) 722-6775 Monday through Friday between 6:00 A.M. and 6:00 P.M., Pacific Standard Time, to arrange for service or repair work or to order replacement parts.

Standard on-site service hours are Monday through Friday, 8 A.M. to 5 P.M., Pacific Standard Time. You can arrange for other hours through a customized service contract.

We provide service beyond the original warranty period of one year as needed. Repair work that is done after the original warranty expires is guaranteed for 3 months. Full service contracts extend the warranty period and can be customized to your specific requirements.

We encourage you to attend a maintenance and repair training course for your instrument. In general, we find that better trained customers experience greater instrument up-time and make better use of our service resources. Your sales or service engineer can provide you with the course and fee schedule.

Diagnostic Scans

In the course of troubleshooting, Tencor Service personnel may ask you to run one or more of the diagnostic scans provided in the scan recipe.

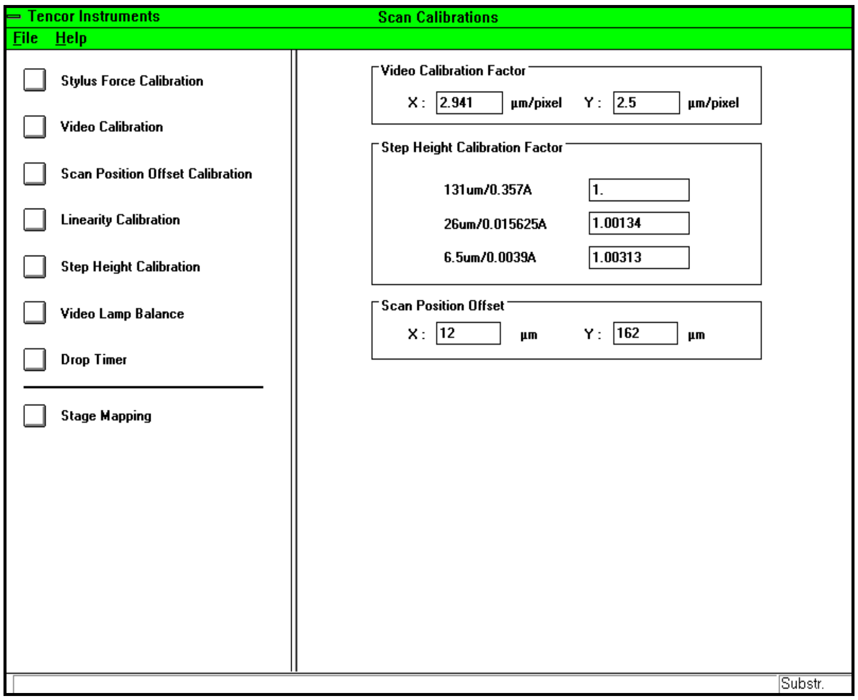
CAUTION: Do not attempt to run a diagnostic scan without advice and instruction from Tencor Service.

Calibration

The Scan Calibrations window gives you access to the calibration functions you need to obtain consistently accurate data. Manually calibrating the instrument serves mainly as a diagnostic tool and an accuracy check of the calibration settings.

If you experience any problems, or have any questions about the performance of the MicroHead, check the calibration settings by following the procedures described here. If recalibrating does not eliminate the problem, or if you cannot obtain reasonable calibration settings, you will need to contact Tencor Service for assistance.

Figure 4-1. *Scan Calibrations window*



Stylus Force Calibration

Stylus force is the force on the stylus tip when the stylus is in contact with the substrate. Mechanical changes in the stylus arm can affect calibration settings.

Note: *Recalibrate the stylus force each time the stylus is changed, especially when operating below 10 mg.*

To check the stylus force setup

1. Click on the Stylus Force Calibration control button in the Scan Calibrations window. The Stylus Force Calibration window appears:

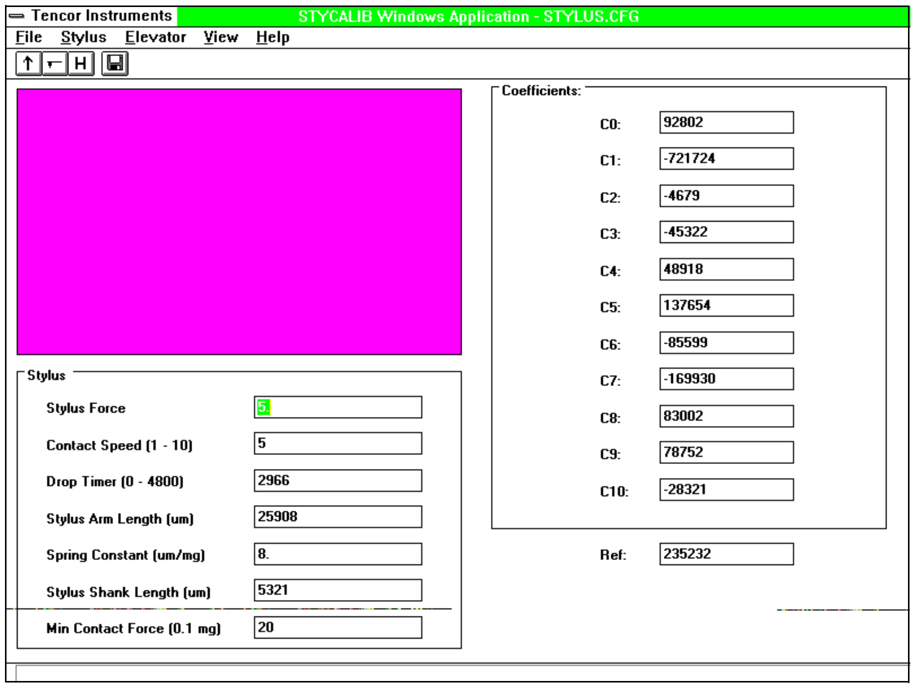


Figure 4-2. *Stylus Force Calibration Window*

2. If the stylus is near a sample surface, select Move Up 500 mm or Move To Soft Home from the Elevator menu.
3. Select Calibrate Force Coefficients from the Stylus menu.

   The stylus force response is calculated and the coefficients C0 to C10 are shown (Figure 4-2).
4. If one of the following is shown, go to DOS, run DCON, and check Force Calibration:

- All the coefficients are 0, or
- The number 8388608 (or -8388608) appears for any coefficient.

5. If neither of the above circumstances apply, choose Save from the File menu to save the new values.

Video Calibration

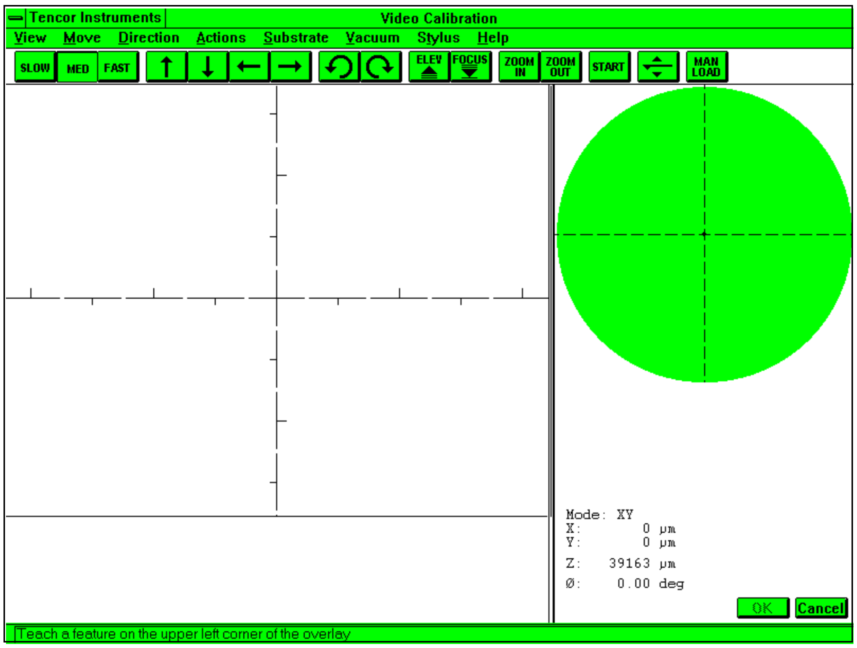
Note: *When performing the Video Calibration at higher magnifications, be sure to select Move Speeds from the Move menu and set the Move Extent for the Slow speed to 1 µm.*

The Video Calibration relates screen coordinates to stage coordinates, which allows accurate teaching of scan lengths and sequence scan locations. The Video Calibration must be performed each time you change the optic magnification (zoom) in an XY View window. To perform the calibration, you need a sample with some clearly distinguishable features, such as a step height standard.

To perform the Video Calibration

1. Load the sample on the stage and locate it beneath the measurement head.
2. From the Scan Calibrations window, click on the Video Calibration control button. The Video Calibration window appears:

Figure 4-3. *Video Calibration Main Window*



3. Click on the Focus button in the tool bar. The stylus nulls on the sample surface and the image come into focus.
4. Choose a feature in the upper left corner of the screen to use to teach the calibration.

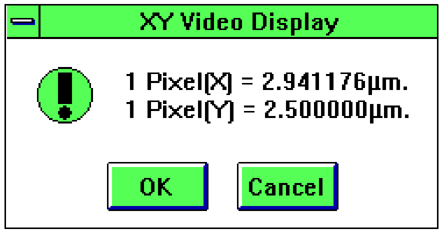
   The corner of a rectangle is ideal. *Avoid choosing something that is identical or very similar in appearance to other features nearby.*
5. Move the cursor, which appears as cross hairs, over the chosen corner and click. The stage moves slightly in the X and Y directions.

   The following message appears on the bottom of the monitor screen:

Teach the Same Feature Again

6. Move the cursor over the chosen corner in its new position and click. The following message box appears:

Figure 4-4. *XY Video Display Window*



The values in the message box are the calculated ratios of vertical and horizontal screen units (called pixels) to X and Y stage coordinates in microns.

7. Click on **OK**. The Scan Calibration window reappears.

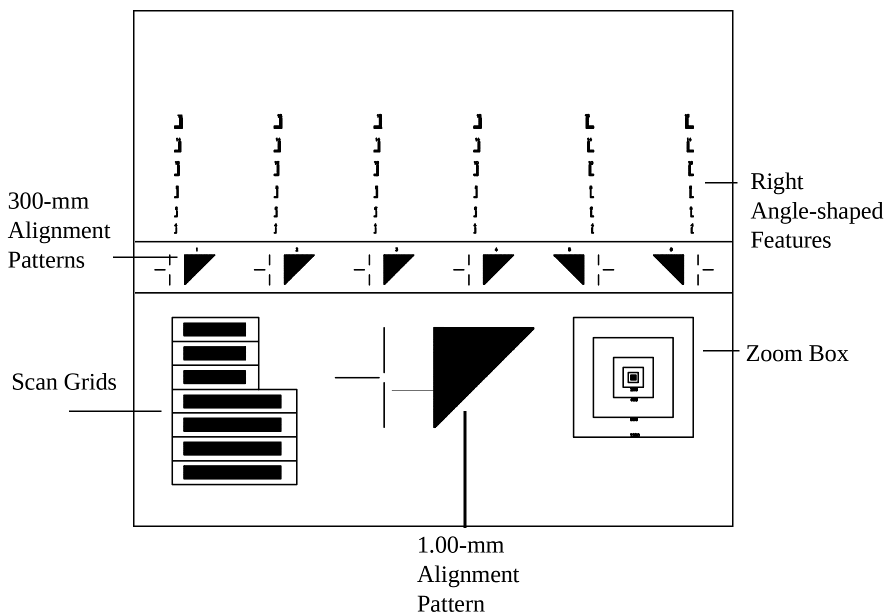
Scan Position Offset Calibration (Windows)

Use the Tencor Stylus Alignment Tool (Tencor Part No. 219517) to determine the distance that the stylus tip is offset from the cross-hairs overlay in the XY View window.

Perform the stylus offset calibration

- When you change the stylus, or
- If you change zoom settings in order to scan a small feature.

Figure 4-5. *Tencor Stylus Alignment Tool*



Note: *Before performing the Scan Position Offset Calibrations, make sure that the optical magnification is at the same setting that the scan will be taken, and that a Video Calibration has been performed as described in the previous section. Note also that when a scan takes place at high magnification, the stylus completely blocks the field of view with non-sideview optics.*

To calibrate the Scan Position Offset

1. Load the Stylus Alignment Tool onto instrument stage so that the alignment patterns are square to the stage X- and Y-axes.
2. Turn on the vacuum.
3. Click on the Scan Position Offset Calibration control button in the Scan Calibrations window.

   The Scan Position Offset Calibration Options dialog box (Figure 4-6) appears in the center of the window:

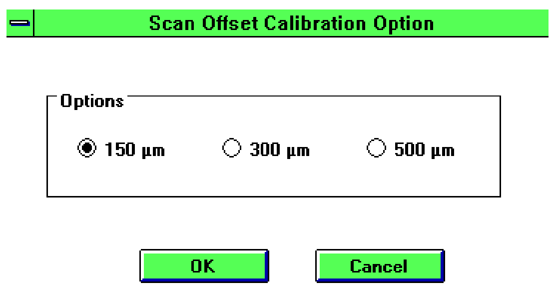


Figure 4-6. *Scan Position Offset Calibration Options Dialog Box*

4. Click on the radio button next to 150 µm to select the 150 µm calibration option.
5. Select the recipe.

   The profiler provides default and custom calibration recipes for each range. To use the default recipe, click on **Continue** or **OK**.

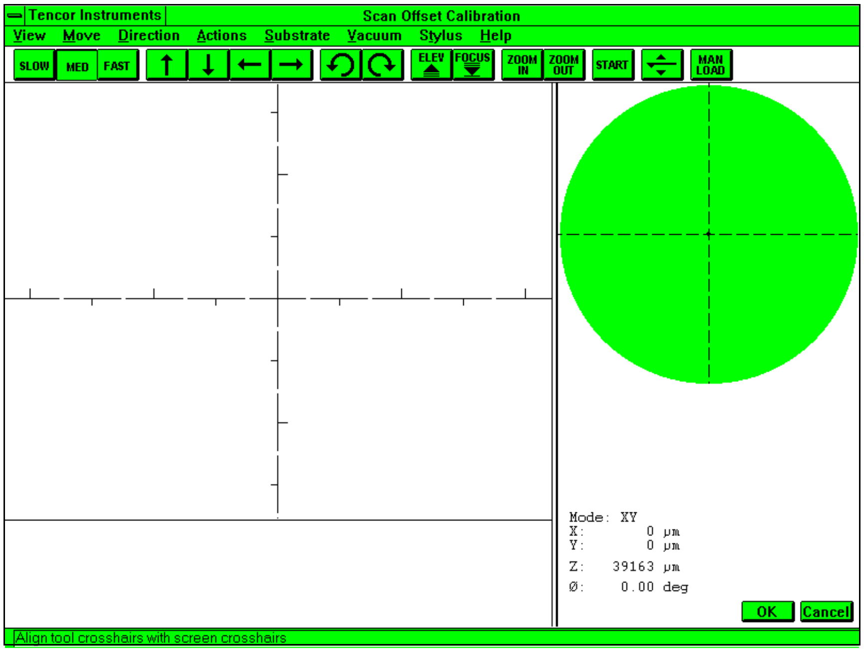
   To see that recipe, click on **Custom**, and the Recipe Editor window appears showing the parameters for that recipe. If you change the parameter(s), save and exit the editor window, this window shows that you are using a custom recipe.

   If you wish to return to the default parameters, click on **Default**, and the message, **“Copy default to custom recipe?”** appears. Click on **Yes** to replace the custom with the default parameters.
6. Click on **Continue** to proceed.

   The Scan Position Offset Calibration window appears:

Note: *The profiler automatically provides filenames for Custom recipes. The first character of the filename has an underscore. For example, _OFF150 refers to the file for the 150 µm size (range) custom offset recipe.*

Figure 4-7. *Scan Position Offset Calibration Window*



7. Click on Focus in the XY View tool bar to lower the measurement head until the sample surface is visible and the stylus nulls on the surface.

8. Locate one of the 150-µm cross-hairs alignment patterns (Figure 4-8).

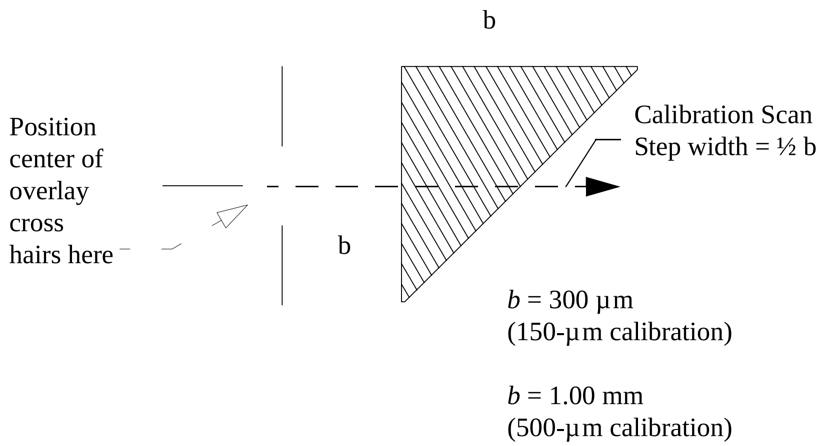
   There are two different-sized alignment patterns for the Scan Position Offset Calibration on the Stylus Alignment Tool (see Figure 4-5 on page 4-5). Both have right triangles with two equal sides; one has 300-µm sides (for the 150-µm calibration option), the other has 1.00-mm sides (500-µm calibration option). There are six of the smaller, and one of the larger patterns.

   Use one of the 300-µm patterns with the 150-µm calibration first. If the stylus offset is too great, the calibration scan will miss the triangle. In that case, try the 1.00-mm pattern using the 500-µm calibration option, then repeat the 150-µm calibration.

   If the calibration scan misses the 1.00-mm triangle, the stylus needs to be physically realigned by an authorized Tencor Instruments service representative.

9. Align the cross hairs of the video overlay with those of the pattern so that center matches center. This produces a trace path as shown by the dotted line in the following figure.

Figure 4-8. *Cross Hairs Alignment Pattern*

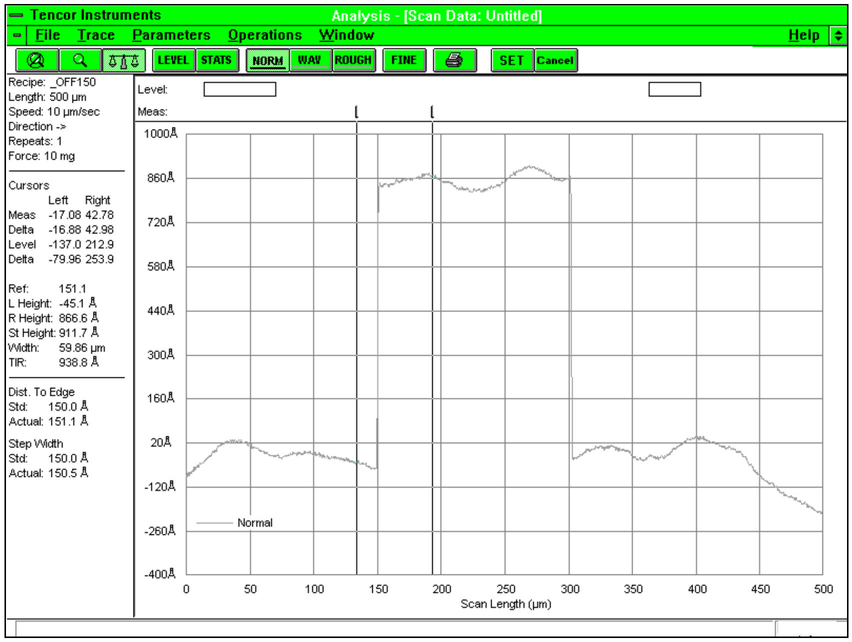


Note: *If precision alignment for sequence operation (features <10 µm) is required, the optical magnification must be at maximum zoom, and the Video Calibration must be performed, or the Scan Offset Calibration cannot be accurate.*

10. Click the **Start** button in the tool bar. The stylus lowers and the instrument scans the triangle at the point where the step width equals half the length of the sides—150 µm for the 300-µm triangle and 500 µm for the 1.00-mm triangle.

11. When the scan is completed, the following Data Analysis window, in this case for a 150-µm calibration, appears (Some versions only display a Stylus Offset Calibration window). Except for correspondingly larger values, the Data Analysis window for a 500-µm calibration appears the same.

Figure 4-9. *Scan Offset Data Analysis window*



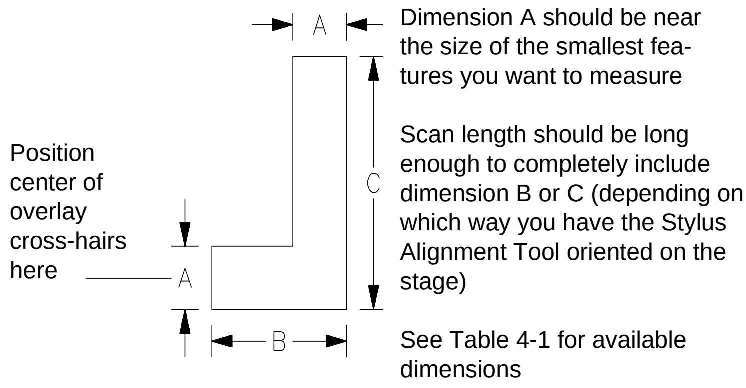
12. *If the actual values for Distance to Leading Edge and Step Width are within 2 µm of their standard values*, click on Cancel in the tool bar to keep the existing offset values.

    If the actual distance and width values are more than 2 µm from their standard values, but still relatively close, click on the **SET** button in the tool bar to accept the new offset calculation. Then repeat the scan until the distance and width values fall within the 2-µm acceptable range.

    If the distance and width values are substantially different, the current offset is too great to allow recalibration using the 150-µm calibration option. Click on Cancel in the tool bar and return to Step 3. In Step 4, choose the 500-µm calibration option and repeat the scan on the 1.00-mm alignment pattern.

Note that it is difficult to verify the accuracy in the Y dimension. Therefore, it is a good idea to check your calibration before proceeding to scan samples. The Stylus Alignment Tool provides a set of right-angle-shaped features (refer to Figure 4-10) of varying dimensions that are useful for checking the calibration. Use the feature that has dimensions on the order of the smallest features you intend to measure

Figure 4-10. *Right-Angle-Shaped Feature*



To check the Scan Offset Calibration

1. Locate one of the right-angle-shaped features (see Figure 4-10) with the center of the cross hairs and perform a scan (see Table 4-1 for available dimensions). The scan length you choose should allow you to completely scan across the feature.
2. If the stylus sets down above or below the bottom of the L, the calibration should be redone. (If above, the step width is approximately A instead of B; if below, no step appears).

Table 4-1. *Available Dimensions for Figure 4-10*

A (μm)	B (μm)	C (μm)
4	16	50
6	24	60
8	32	80
10	40	100
14	56	100
18	72	100

Step Height Calibration

Note: *You must calibrate all vertical ranges, and you must calibrate each range independently.*

The vertical sensing transducers in profilers are not absolute devices and, therefore, require calibration. The calibration factors for the available vertical ranges are tuned to 1.00 at the factory.

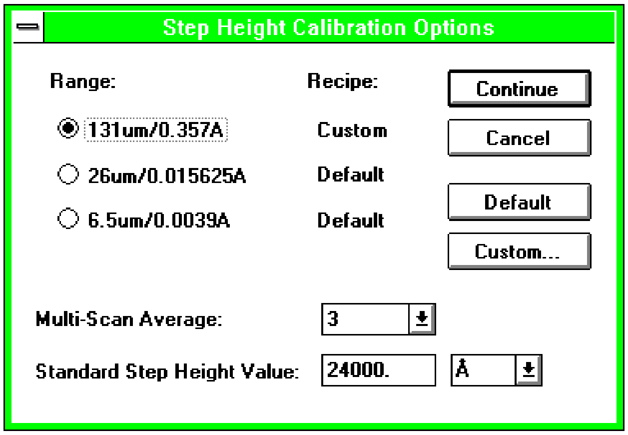
The most precise calibration comes from precision techniques carefully repeated. To promote uniformity in results, the Step Height Calibration routine is automated for routine calibration of each range. The recipes are written for use with VLSI Standards Inc. step height calibration standards. We recommend that you perform the step height calibration monthly.

To perform the Step Height Calibration

1. Click on the **Step Height Calibration** button in the Scan Calibrations window.

   The Step Height Calibration Options dialog box appears:

Figure 4-11. *Step Height Calibration Options Dialog Box*



2. *Range*: Select the calibration range appropriate for the step height standard you are using and click on its radio button.
3. *Multi-Scan Average*: Choose a value for Multi-Scan Average by clicking on the drop-down button and selecting from the list. This number determines how many times the profiler will repeat the scan. Results from each scan are automatically averaged.
4. *Standard Step Height Value:* Enter the nominal step height of the standard you are using into the Standard Step Height Value field, and select the correct units from those available in the drop-down list to the right.

5. Recipe:

   The profiler provides both default and customizable calibration recipes for each of the three ranges. The recipe that will automatically be applied—default or custom—is indicated to the right of the range. (Custom calibration filenames are preceded by an underscore, for example, _STEPHTH is the filename for custom step height recipes.)

   - To use the recipe indicated to the right of the range, click on the **Continue** button to proceed with the calibration.
   - To apply the default recipe when "custom" is indicated, click on Default. The message, **"Copy default to custom recipe?"** appears. Clicking on yes replaces the parameters in the custom recipe with default values.
   - To apply a custom recipe when "default" is indicated or when you want to modify the custom recipe that is indicated, click on Custom... The Recipe Editor opens, displaying the parameters for the custom recipe. Make changes as desired and proceed as if taking a scan.

   The Step Height Calibration window appears.

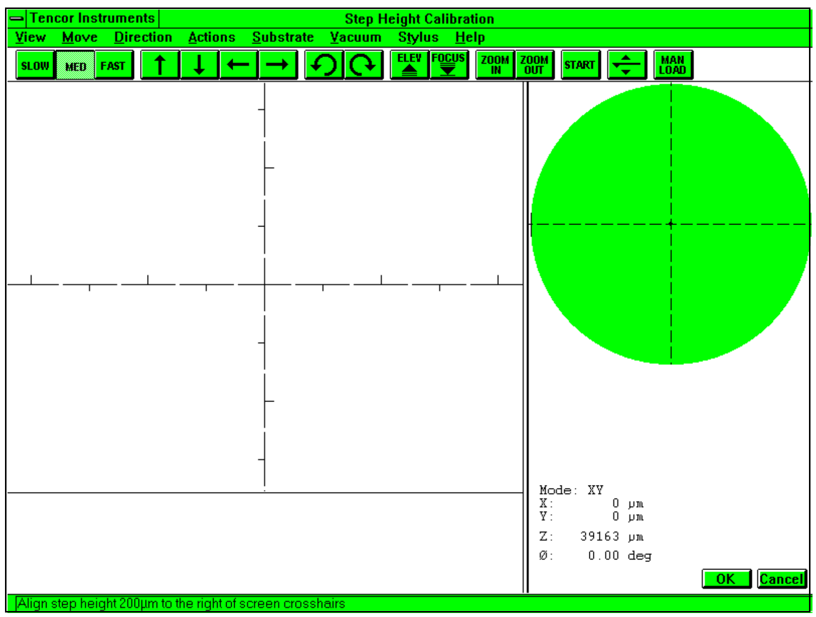


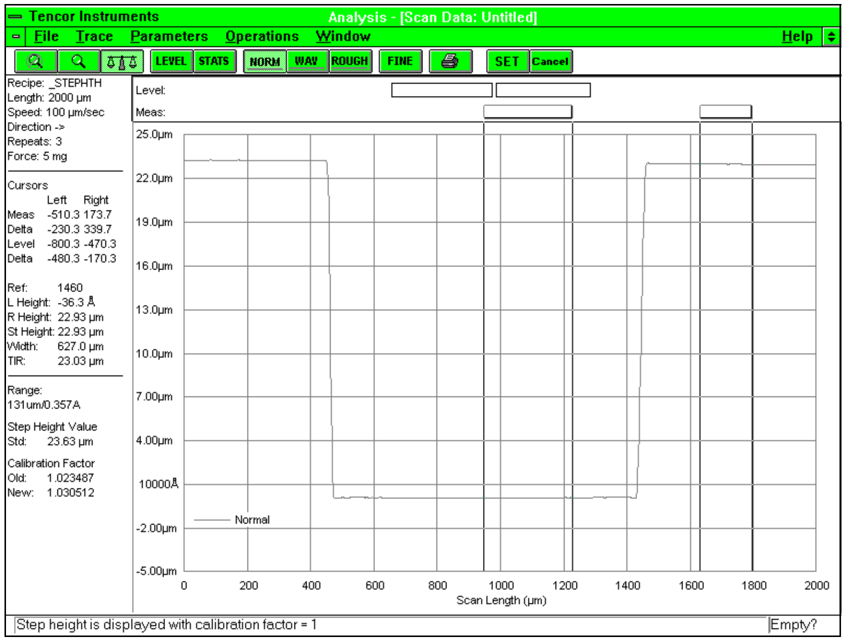
Figure 4-12. *Step Height Calibration Window*

6. Locate the calibration step on the standard, just as you would position any other sample for scanning.
7. Position the cross hairs about 200 µm from the right side of the step height and click on **OK** or on the **Start** button in the tool bar.

   The instrument performs as many scans as you indicated in Step 3. Upon completion, the calibration factor is calculated and shown at the bottom of the Information Area of the Data Analysis window (Figure 4-13).

Note: *Some versions only display a Step Height Calibration result window.*

Figure 4-13. *Step Height Calibration Data Analysis window*



8. Click on Set button in the tool bar to save the calibration factor, or the Cancel button to keep the original value and return to the Scan Calibrations window.

Note: *Remember that the Step Height Calibration must be performed for each range: High, Medium, and Low.*

Video Lamp Balance

The Video Lamp Balance allows you to optimize your view of a particular sample surface. You can vary the total illumination on the sample plus adjust the relative brightness of the two video lamps.

To adjust the total illumination

1. Place a sample on the stage.
2. Click on the Calibration icon in the Top Level menu. The main Scan Calibrations window appears.
3. Click on the Video Lamp Balance button to open its window (Figure 4-14).

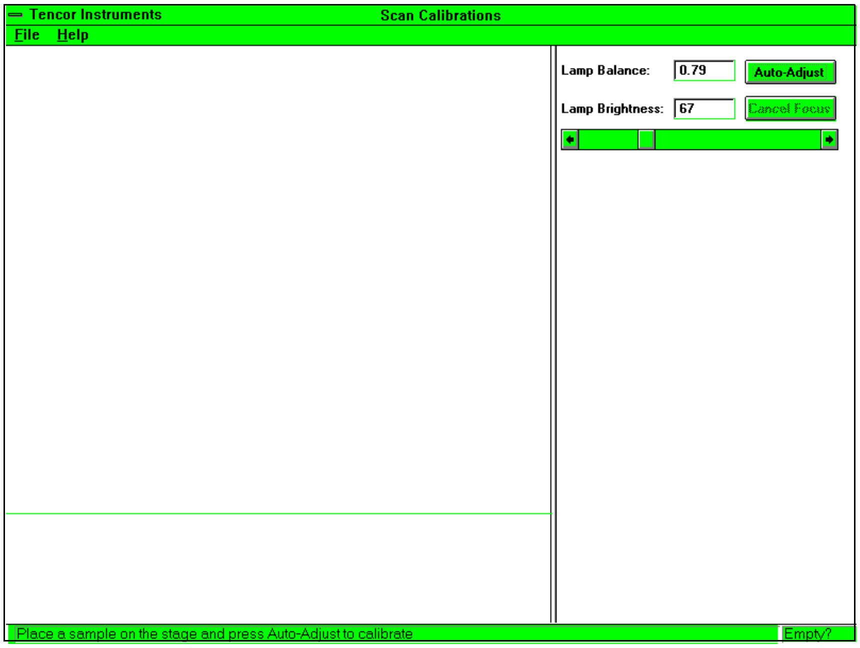


Figure 4-14. *Video Lamp Balance window*

4. Click and drag on the slide bar to adjust total illumination. The value in the Lamp Brightness entry field changes accordingly.
5. Click on Auto-Adjust. The stylus lowers to the sample surface twice, first to measure the illumination from the top-view bulb, then again for the side-view bulb.

   The profiler automatically adjusts the output of the two lamps so that the top-view lamp supplies most of the illumination (lamp balance approximately 0.80 to 0.90). With very low or very high outputs, the top-view lamp supplies almost all of the illumination (lamp balance approaches 1.00).

To change lamp balance

1. Follow steps 1 through 3 in the preceding instructions to open the lamp balance window.
2. Click on the Lamp Balance entry field to highlight the current value.
3. Type the desired value as a decimal fraction less than 1.
4. Choose Exit from the File menu. A message, **"Save changes to EEPROM?"** appears, indicating that the value you have entered will be stored in memory until you change it again.
5. Click on **Yes** to enter the new balance. The screen returns to the main Scan Calibrations window.

Stylus Drop Timer

The Stylus Drop Timer function is a diagnostic tool to be used only under supervision of Tencor Service personnel.

Lubrication

Your instrument uses Tri-Flow™ (Tencor Part No. 069213) and Brayco® (Tencor Part No. 177555) lubricants for servicing the reference flat and leadscrews. The proper lubricant to use is specified on the labels affixed to each lubrication point. *Do not use any other than the specified lubricant.* Follow all the warnings on the Tri-Flow or Brayco bottle.

CAUTION: Do not mix Tri-Flow or Brayco lubricants together: damage to the instrument can occur.

Lubricating X-, Y-, Z-Axis Leadscrews and Reference Flat

The X-, Y-, and Z-axis leadscrews have lubrication wicks to extend the service life and to allow long periods between preventive maintenance.

To lubricate the X- and Y-axis leadscrews and the reference flat:

Note: *Be very careful not to bump the stylus or the sensor assembly when lubricating the leadscrew or the reference flat. You may want to install the stylus protection plate for added protection of the stylus. See "Removing and Installing the Head Assembly" on page 7-16" for details on installing the stylus protection plate.*

Lubricate the X- and Y-axis leadscrews and the reference flat every 12 months based on average use in a relatively clean environment.

(For the P-22, omit step 1. Access is obtained through the front door of the head area. Start with step 2.)

1. Remove the left side panel. Each side panel is held by two thumbwheel knobs on the inside upper corners. Support the side panel from the outside and unscrew the thumbwheel knobs, then gently lift the side panel away from the instrument.
2. Use a clean-room wipe to remove any dirt or excess lubricant on the leadscrews. Move the stage around using the trackball to clean the entire length.
3. Put several drops of Brayco lubricant on the leadscrews and move the stage around to distribute the lubricant and recharge the wick. Continue adding the lubricant and moving the stage until about 10 drops of the lubricant have been added to each screw.

Note: *Do not use solvent to clean the reference flat unless essential.*

4. Move the stage all the way to the rear. Take a fresh clean-room wipe and carefully wipe all lubricant and dirt from the front of the reference glass flat. Put 5 or 6 drops of Tri-Flow lubricant on the front of the reference flat and spread with a different clean-room wipe. Wipe off any excess lubricant.
5. Move the stage all the way to the front and repeat the procedure in the previous step on the rear part of the reference flat. The lubricant must be evenly spread over the entire surface. Move the stage to the front, back, and side-to-side repeatedly to ensure that the lubricant is adequately spread.

To lubricate the Z-axis

Lubricate the Z-axis leadscrew every 12 months based on average use in a relatively clean environment.

1. Remove the left side panel. Each side panel is held by two thumbwheel knobs on the inside upper corners. Support the side panel from the outside and unscrew the thumbwheel knobs, then gently lift the side panel away from the instrument

You also can access the lubrication hole in the elevator post through the measurement area door. Be very careful not to bump the stylus or the sensor assembly if accessing the lubrication hole from the front of the instrument. You may want to install the stylus protection plate for added protection of the stylus. See step 3 in "Removing and Installing the Head Assembly" on page 7-16 for details on installing the stylus protection plate.

2. Raise the elevator to the top. The Z-axis leadscrew is lubricated through the hole in the elevator post near the center.
3. Add two drops of lubricant into the lubrication hole and move the elevator up and down. Repeat until 10 drops of lubricant are added.

Motorized Level and Rotation Stage

Lubricate the Motorized Level and Rotation stage once every 12 months. Use Tri-Flow or Brayco only, as specified on the labels affixed to each lubrication point of your instrument.

To lubricate the Level Adjust Leadscrew

1. Make a note of the level position so that you can return the stage to its original level position after lubrication. To note the level position:
   a. Double-click on the Configuration icon in the Top Level menu. The Configuration window opens. The Level position is listed in the Stage Configuration box under Leveling Offset.

DOS

2. Press the spacebar and [↑] or [↓] to move the motor through its range of travel. Wipe any dirt on the leadscrew with a fresh, dry clean-room wipe.
3. Add two drops of lubricant to the level adjust screw and use [↑] or [↓] to move the motor through its range of travel so that the lubricant is spread evenly.
4. Return the table level motor to or near the original Mechanical Level Angle.

To lubricate the Theta Rotation Gear

To lubricate the Theta Rotation gear, use only the lubricant (Brayco) specified on the labels affixed to each lubrication point of your instrument. Lubricate the gear every 12 months.

1. Remove the front sheet metal plate.
   - Loosen the two 4-40 screws holding the plate.
   - Lift the plate away.

CAUTION: Be very careful not to bump the stylus or the sensor assembly when removing the table top. Install the stylus protection plate for added protection of the stylus.

See "Removing and Installing the Head Assembly" on page 7-16 for details on installing the stylus protection plate.

2. Wipe off any dirt on the Theta Rotation gear using a fresh clean-room wipe. Rotate the Theta Rotation gear by clicking and holding on one of the theta rotation buttons in the tool bar.

3. Remove the rechargeable wick. To reuse the wick, clean it using a clean-room wipe. You also can replace the wick if it is excessively dirty.
4. Add approximately 25 drops of lubricant to a new wick or add approximately 10 drops to the cleaned wick until it is evenly saturated without dripping.
5. Install the wick. The wick should not drip when touching the theta gear.
6. Rotate the Theta Rotation gear to evenly distribute the lubricant. Also, wipe up any drips.
7. Install the front sheet metal plate.

Turning Off or Resetting the Instrument

Before powering down the instrument, we recommend that you:

- Exit the Tencor Profiler software into the Windows desktop.
- Exit Windows

CAUTION: When the instrument is powered up or reset, the stage moves to the Z coordinate of the Manual Load Position. If the Z coordinate is not high enough above the stage, the measurement head might contact any sample or other hardware that might be present. Refer to the section, “Manual Load Position,” in the Operations Manual, for procedures to reset the Z coordinate.

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

CAUTION: Never press the On/Off switch when the disk drive is in operation, otherwise, data, recipe, or program corruption can occur.

To exit to Windows

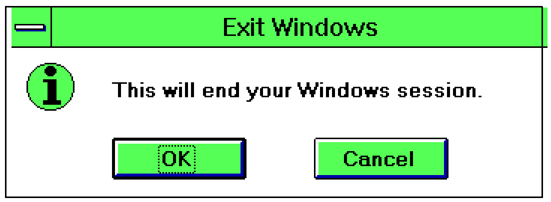
While holding down the SHIFT key, double-click on the **Log Off** button in the Top Level menu. The Tencor Profiler program closes and the screen reverts to the Windows desktop.

To quit Windows

1. Double-click on the **Program Manager control** button, or press ALT+F4. (If the Program Manager window is not open, double-click on its icon first.)

   The following message box appears:

Figure 4-15. *Exit Windows Message Box*



2. Click on **OK** to exit, or **Cancel** to remain in Windows.

To power down the instrument

Turn off the On/Off switch on the computer.

5

MECHANICAL ALIGNMENTS

This chapter discusses mechanical alignments that you must complete when installing, maintaining, or repairing the instrument.

Required Tools

To align the profiler, you need the following:

- VLSI Model SHS-9400, 9400 Å Step Height Standard, P/N 080128
- Razor Blade fixture
- X-drive Spacers (3), P/N 151033-19
- One thin blade screwdriver
- One flat blade screwdriver
- Two strips of shim stock of 0.20" thickness (yellow color), 1ft. x 1/4 in.
- Two strips of shim stock of 0.005" thickness (blue color), 1' x 1/4 in.
- Ruler measuring in 1/10 in. increments
- A pair of pliers
- 10 mm socket wrench
- Thin 13 mm open end wrench
- X-Y Exerciser Calibration Flat
- Set of Standard and Metric Allen wrenches
- Clean room cloth
- Brayco lubricant, P/N 177555

Sensor Arm Assembly

The Sensor Arm assembly provides the Profiler with a highly sensitive mechanism to measure change of surface samples with the output resolution limited by the size of the stylus tip and the supporting electronics. The Sensor Arm assembly is comprised of two capacitor plates, a center vane with an attached plunger, a single pivot, a force coil, and a chassis frame to hold all the parts together.

The Sensor Arm assembly receives its 50 kHz drive signal from the Head Electronics PC assembly. This 50 kHz drive signal is channelled to the two capacitor plates creating a set differential potential between the two capacitive plates.

The Center Vane is placed between the two capacitor plates. The center vane, with the attached stylus, moves up and down along the contours of the measurement sample, and this movement creates a change in potential between the vane and the respective capacitive plates. It is this change in potential that is measured to provide a specific height value.

The Force Coil and Plunger provide the Sensor Arm assembly with a programmable stylus force and stylus-to-sample contact speed.

Associated Problems

There are different types of problems associated with the Sensor Arm assembly (refer to Table 5-1 on page 5-2).

Table 5-1. *Sensor Arm Problems*

Item	Associated Problems
Capacitor Plates	Scratched or faulty capacitor plates result in a higher noise reading and possible signal loss
Pivot	A bent pivot prohibits friction-free movement of the Sensor Arm assembly, causing a non-repeatable Stylus Offset reading and scan trace data.

Removing the Sensor Arm Assembly

You need the following tools for this procedure:

- Set of standard Allen wrenches
- Thin flat blade screwdriver

To remove the Sensor Arm assembly

1. Protect the Sensor Arm assembly by mounting the Stylus protection plate onto the base of the measurement head assembly.
2. For easy removal and re-installation of the measurement head, lower the measurement head so the stylus protection plate is resting on the Measurement Stage.
3. Exit the Profiler into MS-DOS.
4. Turn the power off on the instrument.
5. Disconnect the cables from the Head Electronics PC assembly.
6. Remove the four screws securing the measurement head assembly.
7. Remove the measurement head assembly from the profiler.
8. Place the measurement head assembly on a flat table in a position so that the Sensor Arm assembly portion of the head is extended over the edge of the table.
9. Remove the Stylus Protection Plate from the measurement head assembly, as follows:
10. Disconnect the Sensor Arm assembly cables from the Head Electronic PC assembly.
11. Remove the head cover shield surrounding the measurement head.
12. Use an 0.05" Allen wrench to remove the lift string screw.
13. Use a 9/64 in. Allen wrench and unscrew the two screws securing the Sensor Arm assembly to the boom.
14. Peel the Sensor Arm assembly cables from their holders.
15. Remove the Sensor Arm assembly from the measurement head assembly.

Installing the Sensor Arm Assembly

To install the Sensor Arm assembly

1. Mount the Sensor Arm assembly onto the boom with the two 9/64” screws.
2. Carefully dress the Sensor Arm cables on the two cable mounts.

CAUTION: Be careful that the cables are not pinched at any one location. There should be at least 4 inches of space for the cables between the two cable mounts. The cables should not criss-cross one another (this might allow potential scan noise).

3. Connect the Sensor Arm assembly jack with the red heat shrink tubing to the top female connector of the Head Electronics PC assembly.
4. Connect the jack fitted with the black heat shrink tubing to the bottom female connector.
5. Clean the sapphire disk and the ruby ball on the Sensor Arm assembly with methanol.
6. Install the Sensor Arm assembly and center the stylus roughly in the middle of the optical field.
7. Adjust the down stop so that the stylus tip is about 0.140" below the bottom of the base after it is nulled.

   Use the “protection plate” setup fixture to help align the stylus in the center and get the 0.140" dimension (on top of the spacer).
8. Attach the lift string with 0-80 x 1/8 in. SOC screw and Loctite 222.
9. Loosen the set screw holding the lift motor pulley and manually rotate it to make sure the Sensor Arm assembly does not hit the optics when it is raised and has ample slack when it touches the down stop. The stylus tip should be above the bottom of the base in the raised position.
10. Verify that the string does not rub and rotate the bottom solder lug as needed.

    If necessary, you may need to bend the solder lugs up or back slightly to get best adjustment. The string should lift at a 20° angle to minimize drop bow. Use the bottom lug for course adjustment and the top one for minor adjustment.
11. Re-tighten the pulley set screw.
12. Verify ground goes from the head base to the system ground point through the braid on the elevator. When the top cover is closed and one screw is tight, you should get conduction to the top cover and to the front top and bottom covers.
13. Verify ground goes from the PCB to the screws of the standoffs.
14. Verify that sensor ground goes from the vane/hub to the PCB test point with less than 5 Ω (but not connected to the base casting ground).
15. Install the thermister assembly so the thermister is to the right of the optics assembly and at least 1/4 in. away from any metal.
16. Plug in all cables and tie the optical sensor wires to the bracket so there is ample service loop when the top is open. Loosely tie the cables without damaging the fragile white coil/ground wires. Route the white capacitor plate wires with tie wraps smoothly so wires do not touch.

Sensor Arm Assembly Tests and Calibration Using DCON

This series of procedures uses a combination of tests and calibrations to verify the performance of the instrument.

To test and calibrate the Sensor Arm assembly

Note: *The* DSPB *or* DSPM2 *program must be in the same directory as the DCON and should be at least Jan. 11, DCON and Jan. 23, DSPB,cld (Ver 1.2.7) or DSPM2.cld (Version2.3.7).*

1. Turn (from MS-DOS) the power on to the instrument and run DCON without the profiler software open. DCON is located in the following directories:
- Windows - C:\ORCA\SYSCFG
- DOS - C:\TENCOR
2. Verify that when DSPB installs, the initial tests pass, and show the correct head type that matches the label on the front, and the FIFO size is 4096, and note the following:
   - If the monitor displays an incorrect head type, you need to switch the jumper in the middle of the head electronics PCB. Later cover versions have a hole for access to the jumpers.
   - If the Head has never been initialized, press the **e** key to go to EEPROM commands, and press the **i** (lowercase-I) key to initialize.
   - If the head has already been initialized, the program will ask you twice. If you do initialize it, you erase all calibrations.
3. Press the **t** key to run the self test and verify that the monitor shows the instrument has UPI PCB Revision E or higher.
4. Test the FIFO a few times:
   a. Press **d** to run the debug command.
   b. Press **d** to run the DSP command.
   c. Press **s** to run DSP self-test.
   d. Press **t** to test the FIFO.

Note: *You may have trouble with calibration if the range starts with more than the available travel (since it's not calibrated).*

5. To download normal DSP code, do one of the following:
   a. Exit out of DCON and return to DCON to download normal DSP code
   b. From the DSP Commands menu, press the **a** key to download the default DSP program).
6. Press **e** to start the EEPROM commands.
7. Press **c** to Adjust Gain Calibration, and enter one of the following values (if the Head has been re-initialized):
   - 2 for MicroHead
   - 5 for *sr* MicroHead
   - 12 for *xr* MicroHead.

8. Press **o** to go to oscilloscope mode, and check the functions of the calibration channel by gently lifting up stylus and down with the tie wrap to see that it has full range.

   If needed, do the following:

   a. Press **g** to change to full gain and verify that the range is roughly centered.
   b. From the main menu, press **s** for Scan.
   c. Press **l** (lowercase-L) key to take a linearity scan.

9. Start the trace by pressing ENTER four times.

   The trace starts on top, quickly drops down, and returns with a little hysteresis. If it goes up instead of down the coil is backwards and you must switch the wires in the connector.

10. Press **q** to return to the main menu.
11. Press **o** to go to oscilloscope mode.
12. Press SHIFT-S twice to turn on the second trace, force volts.

Note: *CCW raises the signals but be very careful not to screw out of the lever and destroy the pivot.*

13. Press the **i** (lowercase-I) key to start oscilloscope initialization, and adjust the stylus force adjustment screw until the Signal Channel and the force voltages are both in the center.

    If the screw has too much resistance the screw may be running out of adjustment. To correct this, you must release the pivot set screw and re-tighten the adjustment screw in the middle of the range. The average reading should be under 200,000 force volts.

14. Press **q** to exit and press the **f** key to enter the Stylus Lift/Drop Force commands.
15. Verify that the Stylus Lift/Drop Force commands can pick up and drop the sensor (use **d** for stylus down and **u** for stylus up DCON commands).

    If you get a "blocked" message, you can look at what happened by entering the following commands:

    a. Press **q** to quit this menu and move up one menu level.
    b. Press **s** to initiate another scan.
    c. Press **d** to display the last scan taken.

    You may need to preset the drop timer value to get it to pass. Nominal is 2500 and maximum is 4850.

16. Put a sample on the table and press **q** to return to the main menu.
17. Press **m** to enter the Motion commands.

Note: *Be ready to stop the head with your hand if it fails to null.*

18. Press **n** to null the stylus using the elevator.
19. Press **q** to return to the main menu.
20. Press **f** to start the Stylus Lift/Drop Force commands.
21. Test for the Stylus Drop Timer calibration:

    a. Press **u** to move the stylus up
    b. Press **d** to move the stylus down.

    Compare this number you get with the Stylus Drop Timer. If this number is off by more than 20, do the following:

    a. Press **o** to set sensor drop timer and enter the number.
    b. Press **y** to write that number to EEPROM.

   c. Retest using **u** and **d**.

22. Press **q** to return to the main menu.
23. Press **m** to start the motion commands.
24. Press **z** to home the axis.
25. Press any key to stop the elevator at a convenient height.
    a. Press **q** to return to the main menu.
    b. Press **f** to enter the Stylus Lift/Drop/Force commands
26. Press **c** to start the Calibration Force Curve, use the default 32.
27. Verify that none of the constants saturates at 8,388,607. If an isolation table has covers on and is reasonably quiet, the values will be under 10 for each reading.
28. Verify that the first digit of force coefficient is under 500,000.
29. Exit `DCON` and return to DOS.
30. Start the following program, according to your operating system:

Windows:

a. Type “win” at the drive C: prompt to start Windows.
b. Double-click on the Tencor icon to start the program.
c. From the top level menu, select Calibration and check all calibrations.

DOS:

a. Start the Tencor program.
b. Select Calibration and check all calibrations.

Step Height Calibration

To test the step height

1. Zoom out to lowest magnification to perform the Scan Position Offset Calibration and Video Calibration (in Windows, not DOS).
2. Replace the wafer with a 24 µm standard.
3. Measure the standard using a recipe with a high range and record the reading.
4. Exit the Profiler program and start the DCON program.
5. From the Main Menu, press **e** to enter the EEPROM Commands.
6. Press **c** to Set Calibration Gain.
7. Enter the standard value and measured value as indicated and enter the new value into EEPROM.
8. Press **q** to return to the Profiler program and verify the standard again.

Linearity Calibration

Chapter 6, "Linearity Adjustments" describes creating and using the Linearity Table for DOS and Windows.

Stylus Drop Measurement

You need the following tools for this procedure:

- Thin flat blade screwdriver
- A standard set of Allen wrenches
- `DCON` version, dated 1/23/96 or later.
- `DSPB` version dated 1/23/96 and revision 1.2.7 or greater (for 1.x software), or DSPM2 version dated 1/23/96 or later and revision 2.3.5 or greater (for 2.x software).

When you start `DCON`, the `DSP` code version is shown.

Measure the Stylus Drop Timer for the MicroHead II head with DCON

Perform a stylus force calibration before measuring the stylus drop timer. If you skip the force calibration, `DCON` calculates a correct stylus drop timer; however, it uses an extremely high stylus force (about 150 mg), that could damage the stylus.

Verify that the Sensor Arm assembly can be dropped, and the stylus can travel through its full range of travel without touching the sample. If not, either remove the sample or lift the elevator.

Note: *To abort a null operation, press the* **Space Bar**.

To lift the elevator

1. Run `DCON`, and enter the following commands:
   a. Press **m** to start the Motion system.
   b. Press **z** to home the elevator (wait for the elevator to lift far enough)
   c. Press <**space**> to abort the home command (don't need to lift all the way).
   d. Press **q** to exit the Motion commands.
2. Perform a stylus force calibration. Enter the following commands:
   a. Press **f** to enter the Stylus/Force commands.
   b. Press **c** to enter the Stylus/Force calibration commands.
   c. Press <Enter> to begin the test. Wait for calibration to finish, do not change the convergence threshold.
   d. Press the **Space Bar** to enter the graphics display.
   e. Press **q** to exit the graphics display.
   f. Press **q** to exit the Stylus/Force commands.
3. Null the stylus against the sample. Enter the following commands:
   a. Press **m** to enter the Motion system.
   b. Put a sample under the Stylus.

      There must be a sample for the Stylus to null against. Use a 3.5" disk for this calibration, or a calibration standard.
   c. Press **n** to null the Stylus by moving the elevator.

      If you get a "Dropstate=Blocked" message and no sample was in the way, try reducing the drop timer by 1000 counts. Enter the following in sequential order:

q	To exit the Motion commands
f	To enter the Stylus/Force commands
o	To enter a new Stylus Drop Timer value
Enter the new value	Enter a value between 500 and 1000
n	Do not write to EEPROM
q	Exit the Stylus/Force commands

   d. Press **q** to exit the Motion commands.
4. Drop the Sensor Arm assembly. Enter the following commands:

a. Press **f** to enter the Stylus/Force commands.

b. Press **u** to lift the Sensor assembly.

c. Press **d** to drop the Sensor assembly.

5. Note the Stylus Drop Timer number. After the Sensor Arm assembly drops, the software prints the measurement and the correct value for the stylus drop timer. If no number prints, the sample was not detected within the stylus range.

6. Drop the Sensor Arm assembly two more times to check for consistency. Do the following:

   a. Press **u** to lift the sensor assembly.

   b. Press **d** to drop the sensor assembly.

      Note the new value for the Stylus Drop Timer.

   c. Press **u** to lift the sensor assembly.

   d. Press **d** to drop the sensor assembly.

      Note the new value for the Stylus Drop Timer.

7. Estimate the average of the three readings. The reading will vary over a small range of 10 or 20. If the range is greater than 50, something may be wrong, measure it a few more times.

8. Enter the estimated average value as the new drop timer. Do the following:

   a. Press **o** to enter the new stylus drop timer value.

   b. Enter the average value.

   c. Press **y** to write the data to EEPROM.

9. Drop the Sensor Arm assembly again to verify that the value hasn't changed. If it has changed, return to Step 6 on page 5-10.

10. Exit `DCON`. Enter the following commands:

    a. Press **q** to exit the Stylus/Force commands.

    b. Press **q** to exit `DCON`.

Optics and Lamp Alignment

Note: *You can make a simple fixture out of a business card that is 15 mm wide and has a cross-hair in the center at 5 mm in from the edge and a line 10 mm in to line up with edge of mirror.*

To align the optics and lamp

1. Adjust the Stylus:
   a. Raise the stylus and put a small piece of paper with a cross hair in the center and adjust the top view lamp until you have about 0.3" diameter fully illuminated.
   b. Roughly focus on the cross hair.
   c. Loosen the two 8-32 in. screws and adjust the stylus to be roughly centered when the stylus is lowered.
   d. Adjust the Side View lamp so about 0.2" circle of illumination is centered around the stylus.
2. Remove the paper and null on a patterned wafer with the vacuum on.
3. Focus the top view optics and check that the illumination fills the screen at low magnification, rotate the lamp for the best image.
4. Tighten the two 4-40 in. lock down screws snug. Inspect the image, if there are large spots on cameras that do not move when you zoom, clean the lens.
5. Zoom to high magnification and locate the crosshair on a feature.
6. Zoom to low magnification and loosen the two 8-32 in. screws enough to move the cameras until the pattern is again in the cross hair.
7. Tighten the screws and zoom to verify that it does not move more than 1/8” and that the image stays in focus. If it goes out of focus as you zoom, move the zoom in and out to get the best parfocal imaging.
8. Lower the stylus and tilt the front mirror until you can see the light on a tissue paper hitting the center of the top mirror.
9. Adjust the top mirror until you get pattern on screen that lines up with top view. Focus the side view and readjust the lamp to illuminate the screen with no dark corners on low magnification and rotate for best picture. Use the two 0-80 in. screws on the bottom mirror to move image right and rotate mirror for best centering up and down. Repeat on upper mirror for best picture. If picture is very bad try changing the mirror posts or try different mirrors.
10. Lower the stylus, loosen the two 8-32 in. screws slightly, and move the sensor until the stylus tip is at the cross hairs at best magnification.
11. Verify that the sensor misses the illumination tube when the Stylus is lifted. You may have to bend the top or bottom solder lugs slightly until the Stylus lifts above the bottom of the head without hitting the illumination tube.
12. Verify that all optics screws are tight.

Video Optics

The video optics on the Profiler allow you to view an enlarged test sample image for better definition of areas for examination and testing of the Measurement Stage. The variable image magnification options available for the Profiler are:

- 6.5X (High magnification, standard equipped)
- 4X (Low magnification)

The video optics on the Profiler are independent of the instrument data sampling, processing system, and the motion system. Even if the Stylus image on the screen is centered when nulled, the scan trace is unaffected, providing there is nothing wrong with the Sensor Arm assembly, or the supporting electronics.

Associated Problems

Note: *Tencor specifications for video image drift is 0.4" from center.*

There are seldom problems with the mechanics of the Optics assembly. There will be occasions when the stylus image on the monitor screen is not centered or in focus. This video image can be aligned by either adjusting the Vertical Image Positioning Mirror and/or adjusting the Scan Arm Boom.

Improper adjustments or faulty components in the stylus drop mechanism can cause problems such as the rate of descent of the Sensor Arm assembly, viewed on the video screen, drops too fast or displays the "**Sample Surface too High**" error message while the measurement head assembly continually travels up. When this type of condition occurs, try to change the "Stylus Drop Timer" or the "Contact Speed" parameters. If changing the software parameters offer no improvement in the stylus drop, mechanical alignment is required.

The Profiler uses the "**Sample Surface Too High**" error message to describe that the measurement sample is above the Null position of the Sensor Arm assembly. This message can also occur when the descent of the Sensor Arm assembly is jerky, causing the Center Vane to bounce above the Null position.

The Stylus

The P-10, 11, 12, 20, 22, 30 Profilers use a Stylus as a contact sampling point for topography cans of sample materials. The Stylus comes in various radii of stylus tips. Some radii of stylus is represented by a color band as shown in the table below.

Profiler Hardware-- Stylus Tips				
Part Number	**Stylus Dimensions**	**SensorType**	**Stylus Tip**	**Color Band**
240532	12.5um radius, 60 degrees	MHI, MHII, HRP	L Stylus	Red
217190	5-um radius, 60 degrees	MHI, MHII, HRP	L Stylus	Yellow
270741	2.0-um radius, 45 degrees	MHI, MHII, HRP	L Stylus	Orange
217182	2-um radius, 60 degrees	MHI, MHII, HRP	L Stylus	Green
238203	1.9 - 2.1 um radius, (SEM) 60 degrees	MHI, MHII, HRP	L Stylus	Green
288560	0.05 - 0.10-um radius (SEC) 60 deg	MHI, MHII, HRP	L Stylus	Black
217212	0.1 - 0.2 um radius, 70 degrees	MHI, MHII, HRP	L Stylus	Black
217247	0.2 - 0.8-um radius, 60 degrees	MHI, MHII, HRP	L Stylus	Black
308358	25 um radius, 60 degrees	MHI, MHII, HRP	L Stylus	Blue
410918	.03 -.05-um radius, 40 deg., Durasharp	HRP	L Stylus	Black

A sharper, finer stylus requires lighter stylus force settings when measuring soft materials. When scanning the optical flat with a finer stylus, scan noise will increase.

Associated Problems

Stylus tips get worn from profile scans, or can be chipped by not raising the measurement head to a safe height when loading and unloading samples from the Measurement Stage.

The quality and uniformity of the stylus tip can be examined by measuring it over a test grid of the VLSI Step Height Standard. Finer stylus tips require the “Razor Blade” fixture from Tencor.

A damaged stylus tip can cause unwanted scratches on the scanned sample material, as well as incorrect scan trace data.

Checking the Stylus Tip

You need the following tools for this procedure:

- VLSI Step Height Standard, 9400 Å
- Razor Blade Fixture

To check the Stylus Tip

1. Set the Recipe menu to the values shown in the following table (Table 5-2):

Table 5-2. *Settings for Checking the Stylus Tip.*

Items	VLSI Standard		Razor Blade	
Scan Length	200 µm		500 µm	
Scan Time	20s		25s	
Stylus Force	30 mg		30 mg	
Contact Speed	3		3	
Profile Type	Center		Center	
Vertical Range	13 µm/ 1A		300 µm/ 25A	
Cursor	**L**	**R**	**L**	**R**
Measurement	0	200	0	500
Level	0	190	0	450
Delta Measurement	0	0	0	0
Delta Level	10	10	50	50
Scan Direction	→		→	
Multi-Scan Average	1		1	
Segmented	No		No	

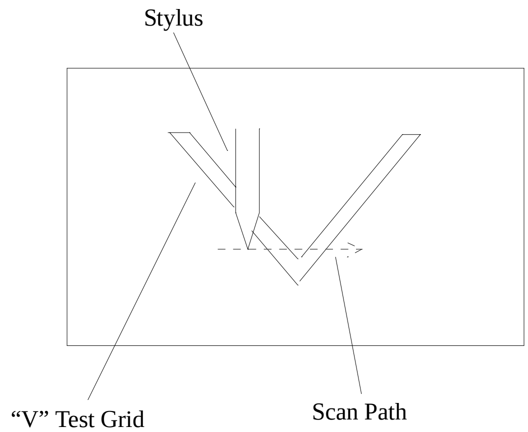
2. Place either the VLSI Step Height Standard, or the Razor Blade Fixture onto the Measurement Stage.

VLSI Step Height Standard

To test the stylus using the VLSI Step Height Standard

1. Null the stylus tip to the outer edge of the V pattern test grid of the VLSI Step Height Standard.
2. Position the stage to have the scan trace over the inner point of the V test grid (as shown in Figure 5-1 on page 5-15).

Figure 5-1. *Checking the VLSI Step Height Standard*



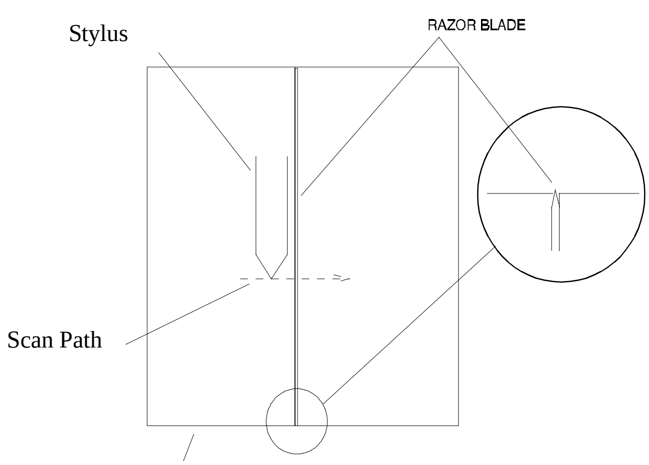
Razor Blade Fixture

WARNING: Be aware that the edge of the tool is razor sharp.

To test the stylus using the Razor Blade fixture

1. Null the stylus tip to the left side of the razor blade (as shown in Figure 5-2 on page 5-15).

Figure 5-2. *Scanning the Stylus Radius Measurement Tool*



2. Press the **Start** key to take a scan.

The scan trace should display a uniform slope detailing the left and right corners of the step. If no such uniformity exists as shown in Figure 5-3 on page 5-16, or Figure 5-4 on page 5-16, replace the stylus.

Figure 5-3. *Profile Trace Using the VLSI Standard*

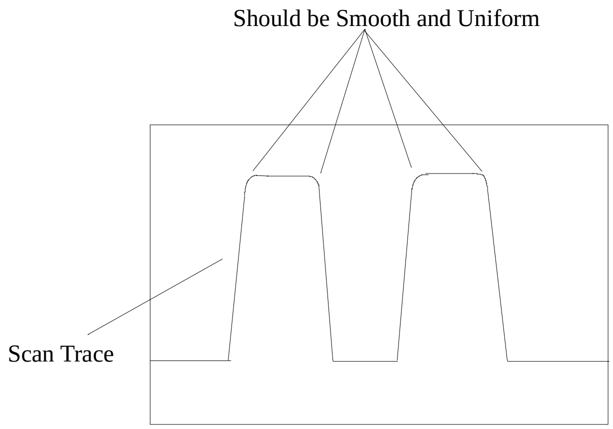
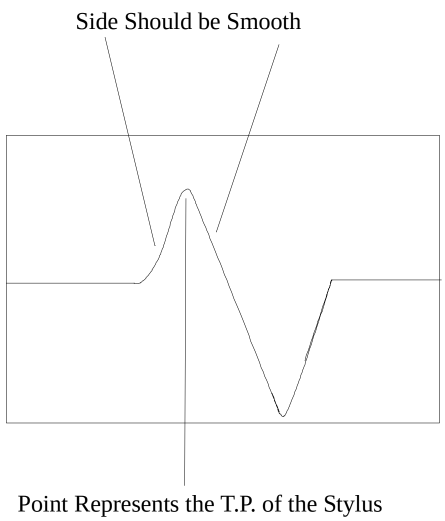


Figure 5-4. *Profile Trace Using the Tencor Stylus Radius Measurement Tool*



Reference Flat

The Reference Flat provides the Profiler a true flat plane for the Measurement Stage to ride on without adding motion noise or geometric distortion of the measurement surface.

The Reference Flat is made of quartz, ground and polished to 0.25 of a wavelength. It is lubricated with a thin layer of Tri-Flow lubricant to reduce the gliding friction of the turcite pads on the X-Carriage assembly supporting the Measurement Stage.

Associated Problems

The Reference Flat should be free of scratches and nicks. A scratch or a nick on the Reference Flat can cause the scan trace measurements taken at those locations to exhibit a distorted, spiked reading.

CAUTION: Be careful not to drop a washer, stylus, or anything sharp that can cause a scratch on the Reference Flat. If something is dropped on the Reference Flat, be sure to remove it before scanning or moving the Measurement Stage in any manner.

Replacing the Reference Flat

You need the following tools to replace the Reference Flat:

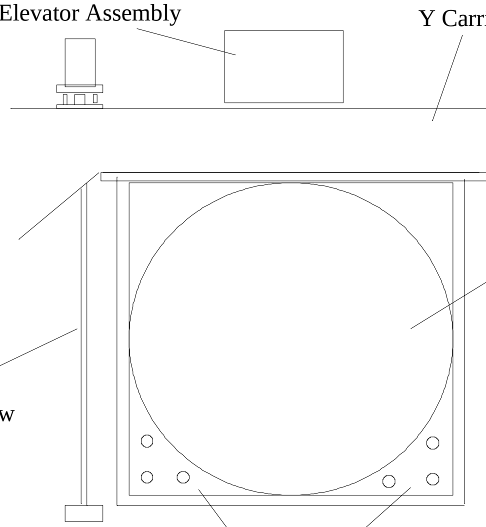
- A set of standard Allen wrenches
- Tri-Flow lubricant, P/N 069213
- Clean room cloths
- RTV silicone
- Reference Flat, P/N 082180

To replace the Reference Flat

1. While operating in the Profiler software, raise the measurement head to its maximum height.
2. Position the Measurement Stage toward the center of the Reference Flat.
3. Exit the Profiler software into MS-DOS and turn the power off to the instrument.
4. Remove the Measurement Stage from the X-Drive assembly.
5. Remove the X-Drive assembly.
6. With your fingers, turn the Y lead screw to move the Y-Carriage assembly to the very back of the Measurement Chamber. This should fully expose the Reference Flat for easy removal. If the X Guide Rail covers a small portion of the Reference Flat, remove it.

7. Unbolt and remove the two front corner flanges (see Figure 5-5 on page 5-18).

Figure 5-5. *Layout of the Measurement Chamber*



8. Remove the damaged Reference Flat.
9. Detach the plastic ring surrounding the Reference Flat.
10. Transfer the plastic ring from the damaged Reference Flat to the new Reference Flat.
11. Secure the plastic ring in place, with a small dab of RTV silicone, half-way up the sides of the Reference Flat.
12. Insert the new Reference Flat into the space in the casting left vacant by the removal of the damaged Flat.

    Note the arrow markings on the new Reference Flat. The direction of the arrow marks the quality side of the Reference Flat, and must face up when lowering the flat into the casting. Make sure the Reference Flat is parallel with the Y-Carriage assembly.
13. Bolt the two front flanges in position on the casting.
14. If removed, attach the X Guide Rail onto the Y-Carriage assembly.
15. Lubricate the Reference Flat with Tri-Flow and polish it, using a circular motion, with a clean-room cloth.

    Remnants of Tri-Flow lubricant should not be visible on the Reference Flat after wiping and polishing with a clean room cloth. Excessive lubricant on the Reference Flat causes higher than normal scan trace noise.
16. With your fingers, turn the Y lead screw to move the Y-Carriage assembly on top of the Reference Flat.
17. Re-install the X-Drive assembly and the Measurement Stage back on the Measurement Chamber.

18. Execute the BURNIN.EXE program to run the Measurement Stage around the new Reference Flat. Let it run for at least 30 minutes.

Note: *Excessive lubricant on the Reference Flat can contribute to higher scan noise.*

19. Exit the BURNIN.EXE program. Take scan noise measurements to check if the new Reference Flat requires additional wiping, or polishing with the clean room cloth.

The X-Drive Assembly

The X-Drive assembly provides motorized-driven support with the capability to absorb and dampen motion noise. Two independent motors provide a wide range of scan speeds. A clutch is used to engage one of the two drive motors to move the Measurement Stage. Positional repeatability is achieved through the use of motor encoders for each motion system.

Motion vibration absorption and dampening is achieved through the strategic positioning and isolation of the moving parts. Isolation is achieved through three piano wires. Two piano wires reduce the transference of motion noise when the scan motors are in operation. The other piano wire reduces the transference of motion noise from the carriage assembly support block, riding on the lead screw, to the Measurement Stage.

Associated Problems

Improper repairs to parts of the X-Drive assembly may create problems later on. The following parts take more time to replace, align, and test:

- The Lead screw
- The Lead screw nut
- The bearings

Problem symptoms with the Lead screw are usually not compound problems. Look for one of the following symptoms:

- A measurement of 1575 µm fullwave period pitch on length scans (the TIR registers above the specification)
- A high PWM readout from the scan motor at particular locations of the X-Drive assembly

A worn Lead screw nut/Preload Spring will exhibit problems in positional repeatability of the Measurement Stage. This is due to increased spacing and decreased tension between lead screw and the lead screw nut.

When you replace an X-Drive assembly, check the X-Carriage assembly for ease of movement and smoothness of motion on the X-Guide Bar; motion roughness is a possible source of scan noise.

Removing the X-Drive Assembly

You need the following tools for this procedure:

- A set of standard Allen wrenches
- Spacers (3), P/N 151033-19

To remove the X-Drive assembly

1. Use the Profiler software to raise the measurement head to its maximum height.
2. Install the Stylus Protection Plate to prevent accidental damage to the Sensor Arm assembly.
3. Move the Measurement Stage toward the center of the Reference Flat.

   The X and Y positional coordinates for DOS should read approximately 105,000 and 105,000, and 0, 0 for Windows.
4. Exit the system and return to DOS.
5. Turn the power off to the instrument.
6. Remove the left and right side panels.
7. Disconnect the cables to the two motor encoders.
8. Remove the cover on the X-Distribution PC assembly and the scan motors.
9. Disconnect the X-Slow Motor, the X-Fast Motor, and the Slow Motor clutch cables from the X-Distribution PC assembly.
10. Remove the three screws holding the stage table top to the supporting mechanical assembly.
11. Remove the X-Carriage assembly, as follows:
    a. Unscrew the three Preloaded Spring-lock screws of the X-Carriage assembly.
    b. Remove the motorized/non-motorized stage.
    c. Remove the two screws securing the X-Carriage to the X-Drive assembly.
12. Remove the X-Drive assembly, as follows:
    a. Loosen the two set screws securing the two piano wires on the two Guide Bars of the X-Drive assembly near the X-Slow Motor.
    b. Gently slide the X-Drive assembly to the right to disengage the two piano wires from the two Guide Bars and lift the assembly upward.

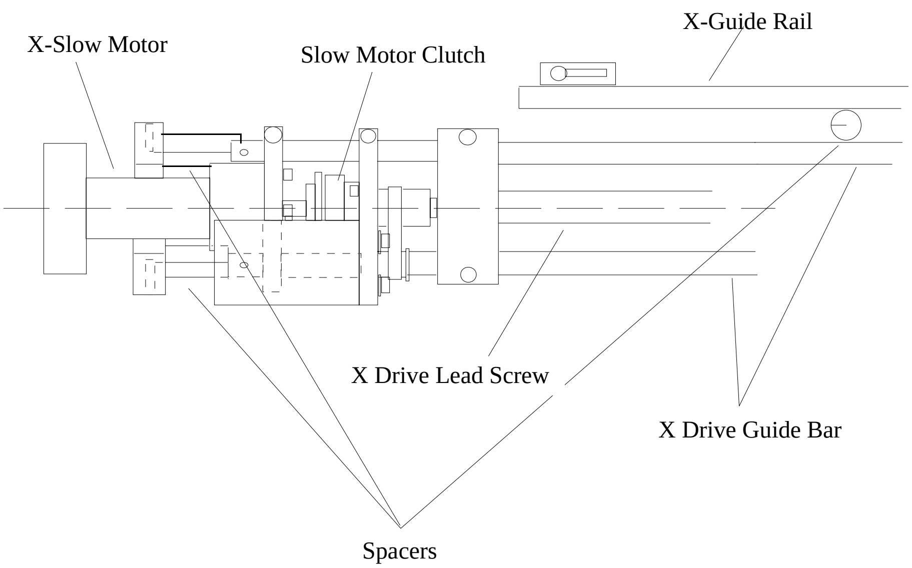
Installing the X-Drive Assembly

To install the X-Drive assembly

Note: *If the piano wires are bent, replace them, otherwise excessive scan noise will occur in scan traces.*

1. Slide the new X-Drive assembly on to the Reference Flat so that the two piano wires slip into the Guide Bar at the end with the scan motors.
2. Place one spacer between the inner Guide Bar of the X-Drive assembly and X-Guide Rail (see Figure 5-6 on page 5-21).
3. Slip the second and third spacers onto the two piano wires, near the scan motor section of the X-Drive assembly (see Figure 5-6).

Figure 5-6. *X-Drive Assembly (partial drawing)*

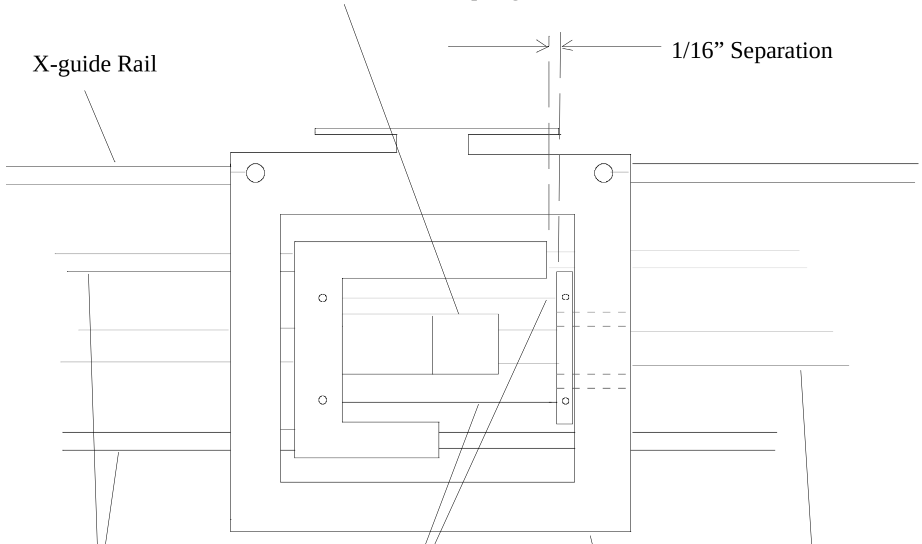


4. Slide the X-Drive assembly to the left and inward so that the spacers press tightly between their respective components.
5. Tighten the set screw at the two Guide Bars to hold the piano wires in place.
6. Remove the three spacers.

7. Bolt into position the X-Carriage assembly to the X-Drive assembly.

   Make a 1/16 in. clearance between the X-Carriage supporting isolation block with the attached piano wires to the guide block mounted on the inner Guide Bar (see Figure 5-7).

Figure 5-7. *X-Drive assembly with Attached X-Carriage assembly*



8. Visually inspect the three piano wires on the X-Drive assembly for a bending load.

   If the piano wire is bending, loosen the set screw to remove the tension imposed on the piano wire. Once the tension is released from the piano wire, tighten the set screw to secure the piano wire in place.

Note: *If the piano wires are still bending, under strain, excessive scan noise will result in scan traces.*

9. Install the Measurement Stage assembly on top of the X-Drive assembly.

Scan Motors

Two independent scan motors drive the Lead screw of the X-Drive assembly. Each motor is monitored by a separate motor encoder connected to the lead screw or to the drive motor shaft. The motor encoder signals identify the position of the Measurement Stage in reference to the home position. These motor encoder signals are in a feedback loop to the motor driver ICs on the Universal Profiler Interface PC assembly for a controlled motion system.

The X-Fast Scan Motor is mounted off to the side away from the inner Guide Bar. It has a drive belt that couples its pulley to another pulley mounted on the lead screw of the X-Drive assembly.

The X-Slow Scan Motor is mounted behind the Clutch assembly and is supported by the two Guide Bars of the X-Drive assembly. The clutch engages the drive shaft of the X-Slow Scan Motor to drive the lead screw for a slow motion scan. During slow motion scans, the X-Fast Scan Motor runs free.

Associated Problems

The scan motors of the X-Drive assembly are very reliable. If the motor does not rotate when energized, replace the motor.

A rare problem would be that the motor would draw more current from the power supply than normal (average load is less than 1 ampere), which would create a current imbalance in the system and may cause the CPU motherboard to automatically reset.

Replacing the X-Fast Scan Motor

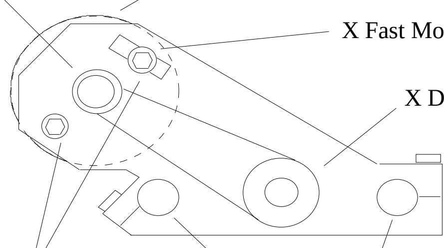
You need the following tools for this procedure:

- A set of standard Allen wrenches

To replace the X-Fast Scan motor

1. Raise the measurement head to its maximum height.
2. Position the Measurement Stage close to the center of the Reference Flat.
3. Exit the system and return to DOS.
4. Turn the power off to the instrument.
5. Remove the cover (shielding the X-Drive assembly motors) from the Power Plate.
6. Remove the Measurement Stage and the X-Carriage assembly from the X-Drive assembly.
7. Disconnect the cables to the X-Drive assembly. Disconnect the two piano wires from the Guide Bar on the X-Drive assembly from the Measurement Chamber. (Refer to Figure 5-8 on page 5-24.)

Figure 5-8. *Mounting the X-Fast Scan Motor*



8. Remove the two screws securing the X-Fast scan Motor to its Mounting Plate.
9. Remove the X-Fast Scan Motor from the X-Drive assembly.
10. Loosen the set screw securing the X-Fast Scan Motor Shaft.
11. Remove the pulley.
12. Slide the pulley onto the new X-Fast Scan Motor Shaft.
13. Loosely tighten the set screw to the flat portion of the X-Fast Scan Motor Shaft.
14. Loosen the two screws securing the X-Fast Scan Motor Mounting Plate the X-Drive assembly.
15. Mount the X-Fast Scan Motor to the Mounting Plate.
16. Wrap the belt around the two pulleys connecting the X-Fast Scan Motor to the X-Drive assembly.
17. Secure the X-Fast Scan Motor into position.
18. Loosen the two set screw holding the X-Fast Scan Motor pulley in position.
19. Align the pulley on the X-Fast Scan Motor shaft so that the scan motor belt is aligned evenly with the pulley on the X-Drive assembly.
20. Tighten the X-Fast Scan Motor Pulley set screws to the flat portion of its drive shaft.
21. Move the X-Fast Scan Motor Mounting Plate so the scan motor belt is tight.
22. Tighten the two screws securing the X-Fast Scan Motor Mounting Plate into position on the X-Drive assembly.

Replacing the X-Slow Scan Motor

You need the following tools for this procedure:

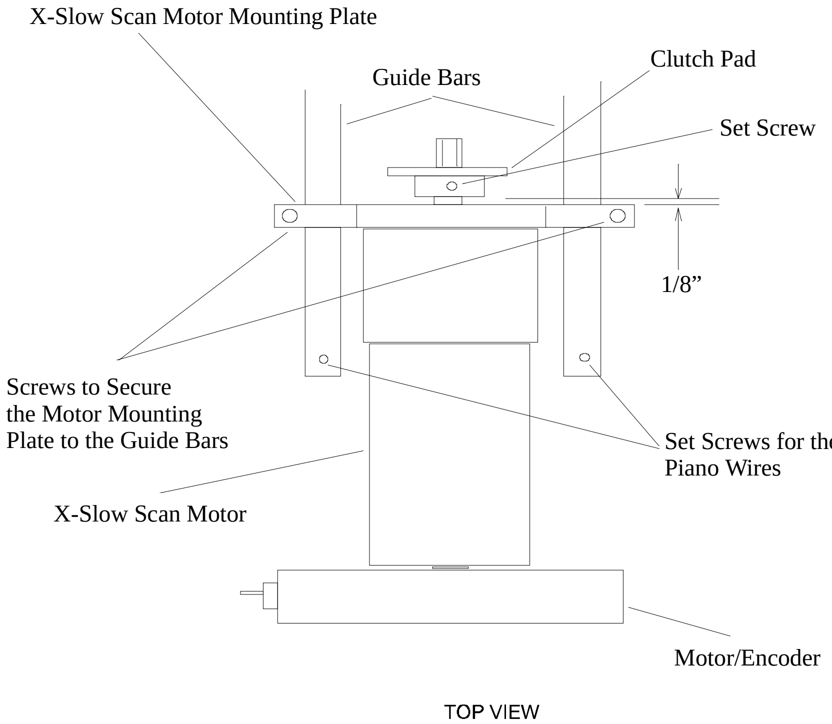
- A set of standard Allen wrenches
- A flat blade screwdriver
- Two strips of shim stock of 0.20" thickness (yellow color), 1ft. x 1/4 in.

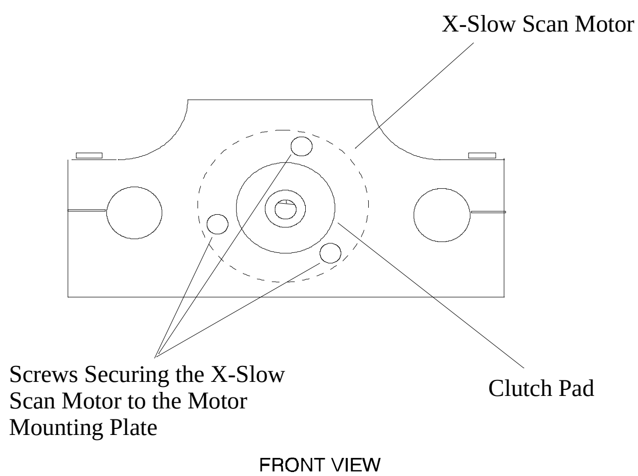
To replace the X-Slow Scan motor (refer to Figure 5-9 on page 5-26)

1. Raise the measurement head to its maximum height.
2. Position the Measurement Stage close to the center of the Reference Flat.
3. Exit the system and return to DOS.
4. Turn the power off to the instrument.
5. Remove the Measurement Stage and the X-Carriage assembly from the X-Drive assembly.
6. Remove the cover shielding the X-Drive Motors.
7. Disconnect the cables to the X-Drive assembly.
8. Disconnect the two piano wires from the Guide Bar on the X-Drive assembly near the X-Slow Scan Motor.
9. Remove the X-Drive assembly from the Measurement Chamber.
10. Remove the two set screws at the X-Slow Scan Motor Mounting Plate securing it to the two Guide Bars.
11. Loosen the two screws on the X-Slow Scan Motor Mounting Plate securing it to the two Guide Bars.
12. Slide the X-Slow Scan Motor with the Mounting Plate outward from the two Guide Bars.
13. Loosen the one set screw on the clutch pad securing it to the X-Slow Scan Motor.
14. Remove the clutch pad from the shaft of the X-Slow Scan Motor.
15. Remove the three screws that secure the front face of the X-Slow Scan Motor to the Mounting Plate.

    This releases the X-Slow Scan Motor.

Figure 5-9. *Mounting the X-Slow Scan Motor*





16. Remove the Motor Encoder from the rear drive shaft of the X-Slow Scan Motor.

CAUTION: Be careful with the encoder wheel. A damaged encoder wheel will obstruct the ability of the drive assembly to move the Measurement Stage to the correct programmed location.

17. Install the Motor Encoder to the new X-Slow Scan Motor.
18. Mount the new X-Slow Scan Motor onto the Mounting Plate, as follows:
    a. Make sure that the motor encoder communication cable connector is oriented toward the X-Distribution PC assembly when assembled onto the X-Drive assembly.
    b. Align the drive shaft of the new motor to be perpendicular to the mounting plate (properly aligning the clutch pad to the clutch plate).
19. Slide the clutch pad onto the drive shaft of the X-Slow Scan Motor, as follows:
    a. Orient the clutch pad so that the set screw sets onto the flat portion of the motor drive shaft.
    b. Slide the clutch pad toward the X-slow Scan Motor Mounting Plate until there is approximately 1/8 in. separating the two components.
    c. Tighten the set screw of the clutch pad securing it in place on the X-Slow Scan Motor.
20. Slide the X-Slow Scan Motor Mounting Plate onto the two Guide Bars of the S-Drive assembly.
21. Slide the S-Slow Scan Motor forward until there is approximately 1/16 in. space between the clutch pad and the clutch plate.
22. Slip two strips of 0.20" shim stock between the clutch pad and the clutch plate, on the left and right side of the center shaft of the clutch.

Note: *The X-Slow motor shaft, and the clutch assembly center must be in line with the Lead Screw, otherwise scan drive oscillation will occur.*

23. Slide the X-Slow Scan Motor forward to have the clutch pad and clutch plate clasped together lightly with the strips of shim stock between them.
24. Check the clutch pad and clutch plate for a concentric mate by feeling its outer edge for evenness (re-position the X-Slow Scan Motor Mounting Plate).
25. Tighten the two screws on the X-Slow Scan Motor Mounting Plate securing it to the X-Drive assembly Guide Bars.
26. Pull the two strips of shim stock from between the clutch pad and the clutch plate.
27. Mount the X-Drive assembly onto the Measurement Chamber.
28. Test the X-Drive assembly for noise spikes by taking a slow lengthy scan using the X-Slow Scan Motor.

    If noise spikes occur in the scan trace, realign the clutch.

Clutch Assembly

The Clutch assembly engages the X-Slow Scan Motor to rotate the lead screw for slow motion scans.

Common problems occur with the contact made between the clutch pad, attached to the X-Slow Scan Motor, and the clutch pate, connected to the lead screw. Uneven surface contact between the clutch pad and plate may cause noise spikes in scan traces during slow motion scans.

Replacing the Clutch Assembly

You need the following tools for this procedure:

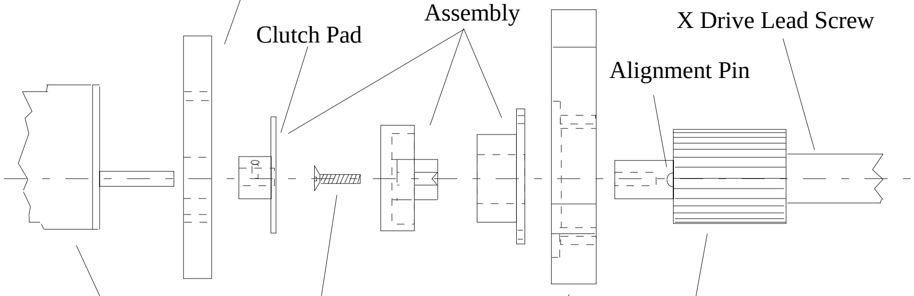
- A set of standard Allen wrenches
- A flat-blade screwdriver
- Two strips of shim stock of 0.005" thickness (blue color), 1' x 1/4 in.

To replace the X-Slow Scan motor

1. Raise the measurement head to its maximum height.
2. Position the Measurement Stage close to the center of the Reference Flat.
3. Exit the Profiler software and return to DOS.
4. Turn the power off to the instrument.
5. Remove the Measurement Stage from the X-Drive assembly.
6. Disconnect the two piano wires at the scan motor side of the X-Drive assembly.
7. Remove the X-Drive assembly from the measurement chamber.
8. Loosen the two clamping screws securing the Mounting Plate of the X-Slow Scan Motor with the attached clutch pad to the guide bars.
9. Slide the Mounting Plate with the X-Slow Scan Motor out from the two Guide Bars.

10. Remove the one flat head screw securing the Clutch assembly to the Lead Screw (see Figure 5-10 on page 5-29).

Figure 5-10. *The X-Drive and Clutch Assembly*



11. Remove the two screws holding the clutch assembly plate to the X-Fast Motor/ Clutch Support bracket.
12. Loosen the two screws securing the X-Fast Motor/Clutch Support bracket to the two Guide bars of the X-Drive assembly.
13. Remove the Clutch assembly from the X-Drive assembly.
14. Insert and secure the new magnetic coil portion of the Clutch assembly to the X-Fast Motor, Clutch Support bracket.
15. Install the new clutch plate:
    a. Slide the new clutch plate on top of the clutch coil and join the slot cut from the plate to the alignment pin on the lead screw.
    b. Secure the clutch plate to the lead screw with the flat head screw.
    c. Slide the X-Fast Motor/Clutch Support Bracket to have the clutch coil pressed against the inner part of the clutch plate.
    d. Place a 0.010" (brown shim stock) shim against the opposite side of the X-Fast Motor/Clutch Support Bracket holding the clutch coil.
    e. Mark with a marker the 0.010" distance created by the shim stock on the X-Guide Bar.
    f. Slide the X-Fast Motor/Clutch Support Bracket to the mark and lock the bracket into position.
16. Replace the worn, or bad, clutch pad from the X-Slow Scan Motor drive shaft with a new clutch pad.

17. Install the X-Slow Scan Motor, as follows:
    a. Slide the X-Slow Scan Motor with the clutch pad onto the two Guide Bars.
    b. Slide the assembly forward to have the clutch pad mate with the clutch plate.
    c. Secure the X-Slow Scan Motor into position by its two mounting screws on to the two Guide Bars.
18. Adjust the clutch pad and plate, as follows:
    a. Loosen the two clamp screws to the mounting bracket securing the X-Slow Scan Motor in position.
    b. Slide the assembly outward to allow a 1/8 in. clearance between the clutch pad and the clutch plate.
    c. Place a 0.020" shim stock (yellow shim stock) on the left and right side of the drive shaft between the clutch pad and plate.
    d. Gently slide the X-Slow Scan Motor assembly inward to have the clutch pad engage the clutch plate holding the shims upright.
    e. Verify that there is even contact throughout the clutch pad to the shims to the clutch plate.
    f. Tighten into position the two clamp screws holding the X-Slow Scan Motor with the clutch pad.
    g. Feel both outer round edges of the clutch plate and pad and make sure they are in line with each other.

       If they are not in line with each other, re-position the X-Slow Motor within the support mount to make it so and re-align the components again.
19. Install the X-Drive assembly in the Measurement Chamber.
20. Re-attach the Measurement Stage.
21. Take a lengthy slow motion scan and verify that there are no spikes or excessive noise in the scan trace.

    If spikes or excessive noise appear in the scan trace, you must align the clutch assembly again (check each step).

The Y-Drive

The Y-Drive assembly provides the Profiler with the Y axis motion (X-Y orthogonality is not a function of the Y-Drive assembly). The Y-Drive is to move the Y axis of the motion system to a specific location under a positioning error minimum.

Associated Problems

The following symptoms could be indicative of a defective Y-drive assembly:

- Motion error when trying to move the stage in the Y direction
- The PWM for the Y-axis exceeds a value of 80%
- Decreased position reliability
- Drift in the Y direction
- High squeaky noise while moving in the Y direction at high speed
- The Y drive goes to one end of the Y direction and locks up once it hits the limit switch.

Using the Y-leadscrew installation kit, P/N 418609, simplifies the repair procedure.

There are several possible problems that can occur with the Y-Drive assembly. By analyzing the Y-Drive assembly in individual components, each component will generate its own unique problems.

Attached to one end of the Lead screw on the Y-Drive is its motion encoder. If the motor encoder sensor is faulty, the Y-Drive would immediately drive toward one end of a limit switch and lock up.

A bad lead screw causes a higher PWM drive and possibly poor Y position repeatability. Similar symptoms occur when the Preload Spring and Lead Screw Nut are worn, and/or have lost resiliency. A faulty support bearing may generate a high squeaky sound at high speed and also generates a higher than normal PWM drive requirement.

A faulty drive motor (by higher than normal PWM drive) can cause the instrument to shut down.

Another symptom is the motion will move rougher in one direction than in another

Replacing The Y-Leadscrew Assembly

Refer to the specific profiler Reference and Maintenance manuals for more details.

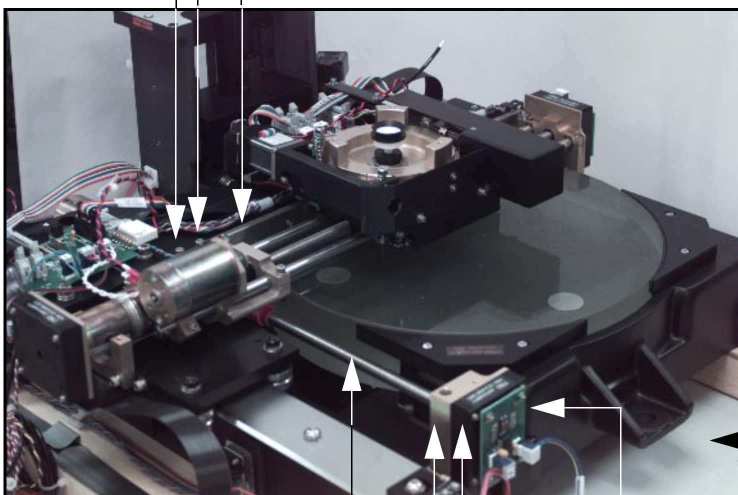
Required Tools and Materials

- 2-56 Spline Wrench
- Standard set of Allen Wrenches/Allen Wrench Ratchet Set (Chapman Kit No. 4320)
- Needle Nose Pliers or Rotor Clip Tool
- Brayco 1624 Lubricant ((P/N 177555)
- Kit, Y-Leadscrew Assy Install (P/N 418609) Includes:

- Y-Leadscrew Assembly (P/N 417947)
- Bearings, Ball, 6mm x 19mm x 6mm (Qty 2) (P/N 193038)
- Retaining Ring,.236 diameter (P/N 101370)

Figure 5-11 is a view of the scanner assembly with all covers removed.

Figure 5-11. *Open view of the Scanner assembly.*



To Replace the Assembly (Refer to Figure 5-12, “The Y-Drive Assembly” on page 5-35.)

1. Turn the power off to the instrument.
2. Remove the left, right and rear panels from the Profiler. If the Profiler is equipped with a handler, it is not necessary to remove the right panel.
3. Remove the two anchor screws securing the Y-carriage assembly to the Y-drive assembly.
4. Loosen the rear 4-40 in. Allen screw on the coupler that secures the Y-leadscrew to the motor.
5. Remove the three screws from the rear leadscrew support block that secures the Y-motor, Y-motor support block, and standoffs.
6. Slide the Y-motor and its attached components toward the rear of the instrument. Position the Y-motor and its attached components out of the way of the lead screw.
7. Remove the encoder cover with the attached buffer board.
8. Loosen the 2-56 in. setscrew (spline) on the encoder wheel.

9. Remove the two screws that secure the encoder reader to the front leadscrew support block.
10. Carefully remove both the encoder wheel and encoder reader.
11. While holding the leadscrew coupler, slowly remove the 4-40 in. sockethead screw from the front of the Y-leadscrew. Use caution while unscrewing the sockethead screw to prevent the compression spring from flying off. Remove the sockethead screw, lock washer, flat washer, encoder bushing, bearing, and compression spring.
12. Remove the coupler from the Y-leadscrew by loosening the front 4-40 in. Allen screw.
13. Remove the two screws that secure the rear leadscrew support block to the chassis.
14. Slide the Y-leadscrew towards the rear of the instrument until it is free of the front Y-leadscrew support block.
15. Ensure that the Y-carriage assembly is placed toward the middle of the Y-leadscrew assembly (to start with—you may need to move the carriage again as you progress through this procedure).
16. The Y-leadscrew assembly and leadscrew support block can now be removed by sliding it back and to the side of the instrument.
17. Remove the retaining ring from the rear of the Y-leadscrew assembly and remove the leadscrew support block and bearing.
18. Install the leadscrew support block and a new bearing (P/N 193038) onto the rear of the new Y-leadscrew assembly (P/N 417947) and secure with a new retaining ring (P/N 101370).
19. Install the new Y-leadscrew assembly back into the Profiler and position the front end of the leadscrew into the front leadscrew support block.
20. Install the two screws that secure the rear leadscrew support block to the chassis.
21. Attach the coupler to the end of the Y-leadscrew by tightening the front Allen screw.
22. To the front of the Y-leadscrew shaft, install the compression spring, new bearing (P/N 193038), bushing, flat washer, lock washer, and 4-40 in.sockethead screw. Ensure that the bearing is properly seated in the front leadscrew support block. Hold the coupler while tightening the 4-40 in. sockethead screw.
23. Once this screw is tight, push the screw in with the Allen wrench and ensure that you feel spring action. If there is no spring action, disassemble the components and try again.
24. Carefully install the encoder wheel onto the Y-leadscrew ***while it is positioned within the encoder reader***. Secure the encoder reader onto the front leadscrew support block. Position the encoder wheel in the middle of the encoder reader then tighten the 2-56 in. setscrew (spline).
25. Install the encoder cover with attached buffer board.
26. Position the Y-motor with its attached components into the coupler at the end of the Y-leadscrew assembly.
27. Secure the Y-motor, Y-motor support block, and standoffs to the leadscrew support block with the three sockethead screws.

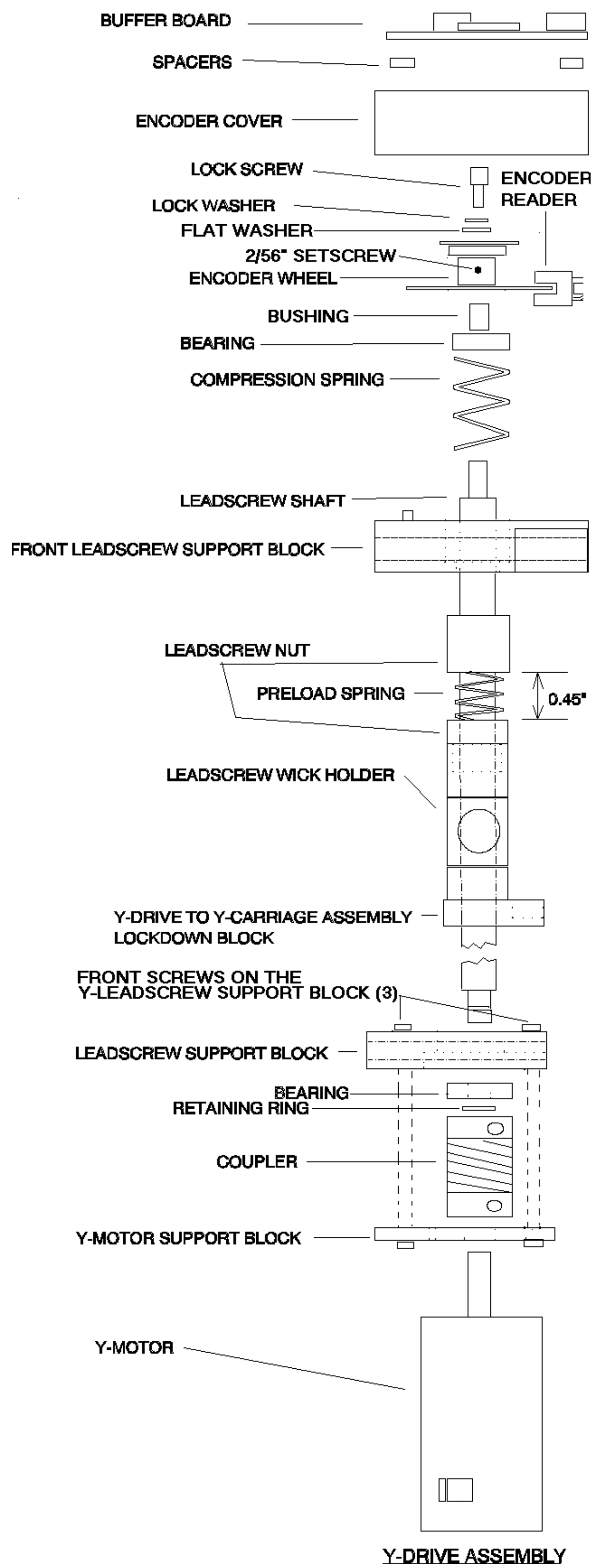
28. Tighten the rear 4-40 in. Allen screw on the coupler to secure the Y-motor to the Y-leadscrew.
29. Apply 1-2 drops per inch of Brayco 1624 lubricant onto the Y-leadscrew.
30. Install the two anchor screws that secure the Y-carriage assembly onto the Y-drive assembly.
31. Turn the power on to the Profiler.
32. Use the Burnin program to burn in the Y-drive assembly.
33. Use the Mottest or the DCON program to check the PWM value of the Y axis. This value should not exceed 90.

Note: *The older DCON program does not have motion control, and none have a burnin feature.*

CAUTION: Motion files are set with PWM limit of 110 and will lock the system up if that limit is exceeded. If lockup occurs, the PWM limit can be temporarily changed to 129. That value should not be saved, as saving the incorrect value will compromise system safety

34. Check for the positional repeatability of the motion system.
35. Once you are satisfied with the performance of the instrument, install the panels.

Figure 5-12. *The Y-Drive Assembly*



V-Journal Bearings

The V-Journal Bearing provides the Profiler a smooth gliding motion on the Y-Guide Rail for the Y travel direction. There are two types of V-Journal Bearings on the Profiler, as follows:

- Concentric
- Eccentric

Two concentric bearings attach to the right side of the Power Plate. The concentric bearings are centered and aligned with its mounting screw.

Two eccentric bearings attach to the left side of the Power Plate. The eccentric bearings are not centered, aligned with its mounting screw. These cam-like eccentric bearings allow for clamp-like adjustment to the Y Guide Rail for a smooth, firm travel motion.

Associated Problems

Bearings eventually wear and lose their smoothness of motion. A bad bearing can cause the motion system on the Profiler to exceed its PWM limit. It can also increase the position repeatability error of Measurement Stage.

Should you replace a V-Journal Bearing, you must test for orthogonality of the X-Y motion axis.

Replacing the V-Journal Bearing

You need the following tools for this procedure:

- 10 mm socket wrench
- Thin 13-mm open-end wrench
- A set of standard Allen wrenches
- X-Y Exerciser Calibration Flat

To replace the V-Journal Bearing

1. Exit the instrument back into MS-DOS.
2. Turn the power off to the instrument.
3. Remove the power cord from its power source.
4. Remove the Measurement Stage and the X-Drive assembly from the instrument.
5. Remove the two Anchor screws securing the Y-Carriage assembly to the Y-Drive assembly lead screw block.
6. Remove the four (4) screws securing the Y-Carriage assembly to the Power Plate.
7. Remove the Y-Carriage assembly.
8. Remove the limit switch at the front of the V-track.
9. Use the 10-mm socket and the 13-mm open-end wrenches to loosen the two eccentric bearings from the Power Plate.

10. Move the Power Plate to free the bearing from the V-track.
11. Use the 10-mm socket and the 13-mm open-end wrenches to remove the faulty bearing from the Power Plate.
12. Install the new V-Journal Bearing in the Power Plate.
13. Move the Power Plate to engage the bearing on to the V-track.
14. Tighten the 2 concentric bearings in place on the Power Plate.
15. Use the 13 mm open end wrench to wedge tightly both eccentric bearings to the Y-Guide Rail and tighten each bearing in its place on the Power Plate.
16. Slide the Power Plate along the length of the Y-Guide Rail.
17. Feel for side to side play of the Power Plate. If there is side to side play on the Power Plate, or should the two halves of the eccentric bearing spin freely while in contact to the Y-Guide Rail, wedge the eccentric bearings tighter against the Y-Guide Rail.
18. Assemble the Y-Carriage assembly onto the Power Plate.
19. Check the two halves of the eccentric bearings to see if the new additional weight has loosened its surface contact to the Y-Guide Rail by trying to spin the two halves of the bearing (only one half of the bearing should spin freely).

    If the two halves of the eccentric bearing spin freely, re-tighten the eccentric bearings to have just one half of the bearing spin freely.
20. Secure the Y-Carriage assembly to the Y-Drive assembly lead screw block using the two anchor screws.
21. Assemble the X-Drive assembly and the Measurement Stage onto the measurement chamber.
22. Check for orthogonality of the X-Y motion system by using the etched borders of the X-Y Exerciser Calibration Flat as the test sample.
23. Null the stylus on the upper left corner of the test pattern on the X-Y Exerciser Calibration Flat.
24. Rotate the stage to make the stylus run parallel to the border of the test pattern when the Measurement Stage moves only in the X direction.
25. Move the Measurement Stage in the Y direction only.

    If the stylus does not run parallel to the Y directional border of the test pattern, realign the Y-Carriage assembly at the Power Plate.
26. Test for X-Y orthogonality of the motion system.
27. When you adjust the Y-Carriage assembly to a new position, check the tension on the Piano Wires on the X-Drive assembly. The piano wires should be free of outside tension.

6

LINEARITY ADJUSTMENTS

This section explains creating a Linearity table to compensate for differences within the instrument.

The Linearity Table provides a series of gain adjustment to produce a linear output through the entire vertical measurement range of the Linear Voltage Differential Capacitance (LVDC), and the Sensor Arm Assembly.

Only use this linearity table when operating in the following ranges:

- 131 µm for MicroHead II
- 300 µm for *sr* MicroHead II
- All ranges for *xr* for MicroHead II

When you replace the Sensor Arm Assembly or the Head Electronics PC Assembly, you must create a new linearity table. The linearity table is a function of the unique characteristic of the measurement device and its amplification circuitry.

The criteria for determining a quality linearity table is that it must have a distortion of less than 0.5% throughout the total vertical travel range of the LVDC. You can verify the specification criteria by re-leveling the scan trace of an inclined scan of a Reference Flat of 1/10 wavelength and measuring the total distortion within the 300 µm vertical travel range.

If you have installed a new Head Electronic PC Assembly, or Sensor Arm Assembly into the Measurement Head Assembly, calibrate the new parts to the existing linearity table.

Required Tools

To make electronic adjustments, you need the following tools:

- 4" or 6" Reference Flat of 1/10 or 1/20 wavelength
- A set of standard Allen wrenches
- 24 µm VLSI step height standard
- 9400 Å VSLI step height standard

Linearity Calibration

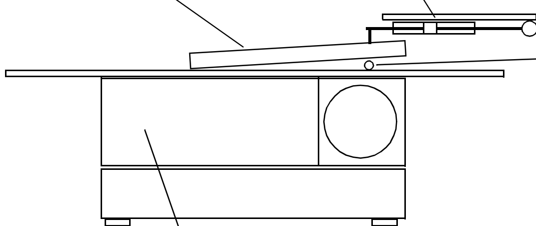
To calibrate linearity

1. In the Scan Calibration window, enter one's for the three calibration ranges in the Step Height Calibration Factor field.
2. Perform a step height calibration on the 24 μm standard.
3. Verify that the measured value is within 1% of the stated value.
4. Place the optical flat near the center of the stage. Move the stage so that the stylus is located over the right quarter of the flat (about 0.5" from the edge).
5. Put a wrench or some other suitable device (see below) under the right side of optical flat so the unit goes through the entire range within at least 10 mm (See Figure 6-1).

For a 6" flat, use the following:

- a 0.02" ruler for MicroHead II
- a 0.05" wrench for *sr* MicroHead II
- a 1/8" wrench for *xr* MicroHead II (do not erase the linearity table)

Figure 6-1. *Optical Flat Position for Linearity Scan*



Perform one of the following for either DOS or Windows:

DOS:

1. Use the LINEAR recipe and set the following:
- 50 mm at 2 mm/s
- 200 Hz with *Arc Correction* set to "OFF"
- *Trace Data* set to "SAVE"
2. Null the stylus
3. Rotate the trackball to the right until the tip of the stylus is barely off of the sample.
4. Press the **ESC** Menu key.
5. Choose the Diag menu and press the ENTER key (SCAN will be selected).
6. Press the **7**, then the **F1** keys.

The monitor displays the following parameters for the Diagnostic scan:

Select Scan Options

Nulling	No
Scan Motion	Yes
Scan	Yes
Noise Filter	Yes
Backscan	Yes

Set the Diagnostic scan parameters as listed above.

7. When you set the Diagnostic scan parameters, press the **F1** key to begin the scan.

   When the scan finishes, the monitor displays the diagnostic menu.
8. Press the **F4** key, and the monitor displays the profile of the scan.
9. Move and position the right cursor to the right corner of the profile to where the slope *just* begins its descent, at the corner point. The right cursor height position registered at this location should be in one of the following ranges:

- 65 for MicroHead II
- 150 for *sr* for MicroHead II
- 500 for *xr* for MicroHead II

10. Move and position the left cursor to the left corner of the profile to where the slope just begins its ascent, at the corner point. The left cursor height position registered at this location should be in one of the following ranges:

- 65 for MicroHead II
- 150 for *sr* for MicroHead II
- 500 for *xr* for MicroHead II

11. Press the **F10** key to activate the leveling cursors.
12. Align the leveling cursors with the measurement cursors.
13. Press the **F10** key again to level the data.
14. Verify that the distance between the cursors is a minimum of 8 mm.
15. In the summary data screen the Total Indicator Runout (TIR) appears.
16. Undo the leveling by pressing the BACKSPACE+**F10** keys.

    Note the left and right cursor height position values.
17. To save the data:

    a. Press the **F4** key.

    A window opens and requests a filename to save.

    b. Type the filename, LINEAR1.

    c. Set Disk Path Export to *C:*, to select the drive C.

    d. From the main menu, select Catalog from the Data menu.

A dialog request asks for the file name.

e. Press the ENTER key to display a list of the saved data files.

f. Use the arrow keys to select the LINEAR1 file.

g. Press the **F3** key to export the file.

A dialog requests that you want to export in Binary.

h. Answer No (N) to export ASCII.

i. Name the LINEAR1.

18. Exit to MS-DOS.
19. Enter DCON.
20. Press **e** to enter the EPROM commands.
21. Press **f** for Curve Fit Linearity.
22. Access the file from *C:\tencor\exp\sdata\linear1.rwt*.
23. Quit the graph.
24. Enter **y** to write the data to EEPROM.
25. Return to the Profiler program and re-check the calibration and linearity.
26. Repeat the calibration and linearity procedures a second time to get within specification (linearity trace about 800 Å TIR typical).

Windows:

1. From the Top Level menu, click on Scan. Null the Stylus, then move the stage to the right until the tip of the stylus is barely off the optical flat.
   a. View/Modify the recipe
   b. Select Recipe from the Diagnostics menu.
   c. Make sure that the NO NULLING parameter is selected.
   d. Make sure the other parameters are not selected (no X is in the box).
   e. Click on **OK**.
2. Select the Linear scan recipe:
3. Go to the XY view
4. Click on the **Start** button to take a scan of the ramp.

   The scan should start on the bottom left, and be flat, then climb up at about 40° to 50° and flatten out again at the top right. If this is not the case, then you need to change either the start position of the scan, or the position of the wrench to change the angle.
5. Move the right cursor to a data point just left of the corner point of the plateau. The cursor should rest on the angled part of the scan just before the flat section.
6. Move the left cursor to a data point just right of the bottom plateau. The cursor should rest on the angled part of the scan as it begins its ascent.
7. The left and right cursor height positions shown in the summary data screen should be

- ±65 µm for MicroHead II
- ±150 µm for *sr*
- ±500 µm for *xr*.

8. Select LEVEL and place the leveling cursor at the same place as the measurement cursors.
9. Select LEVEL again to level the data.
10. In the summary data screen, note the Total Indicator Runout (TIR) value.
11. Exit from the data screen. Do not save the changes to the recipe or the data.
12. Exit out to the Top Level menu.
13. Select the Calibration menu.
14. Click on Linearity Calibration.
15. Select the default recipe.
16. Click on Continue.

    The Optical flat is in the same location from the previous scan.
17. Click on the **START** button.

    When the scan is complete, the program shows the data.
18. Click on the **SET** key to use the scan to calibrate the linearity.
19. The software will perform the Linearity calibration. It will ask the user if they want to update the EEPROM. Click on **YES**. Once the calibration is complete a dialog box will appear saying that the calibration is complete.
20. Repeat steps 1 through 8 to verify that the linearity trace is within specification. Specification is 800Å TIR.

7

MICROHEAD II

This chapter describes the MicroHead II:

- The measurement head
- Removing/Installing the stylus
- Removing/Installing the sample illumination bulbs
- Setup and diagnostics
- Focusing the optics
- Removing/Installing the head assembly
- Shipping a damaged head

The interchangeable MicroHead II provides the Profiler with vertical viewing optics and a contact Profiler with stylus force setting of.05 mg without a loss in the sample surface definition.

The following vertical measurement ranges are available:

- ± 3.25 µm /0.5 Å
- ± 13 µm /2 Å
- ± 65 µm /10 Å

MicroHead II Measurement Head

The Tencor MicroHead II enables the profiler to precisely measure the surface topography of finely textured disks at sub-angstrom vertical resolution, while preserving the true surface condition of the disk. The MicroHead II offers accurate measurement of the features of magnetic and optical disks with excellent vertical repeatability and reproducibility.

Features include:

- Ultra low stylus force down to 0.05 mg, measuring accurate profiles of roughness below 10 Å and features less than 500 Å.
- Innovative stylus arm, offering an extremely low moment of inertia, reducing sensitivity to environmental noise.
- Advanced digital signal processing (DSP), improving control and accuracy with up to 1 kHz sampling rates for faster scans.
- Constant stylus force control throughout the entire vertical sensor range, by incorporating an intelligent sensor to determine surface topography.
- Dual-view optical design (optional), providing a top-down view of an image for stylus positioning, as well as a side-angle view for checking the stylus tip and measured features.
- Color camera (optional), simplifying identification of ultra-thin or color features.

- Automatic positioning of the stylus on the sample surface for enhanced roll-off measurement repeatability.
- Extremely low noise characteristics, enabling measurement of step heights with a repeatability of 8 Å maximum in the 6.5 µm (±3.2) range.
- High resolution 3D imaging of areas more than 500 µm X 500 µm, utilizing the low-drift sensor of the head.
- Proximity detector allows fast descent until near the sample, then automatically switches to slow descent.

The MicroHead II is used for a variety of measurements, including:

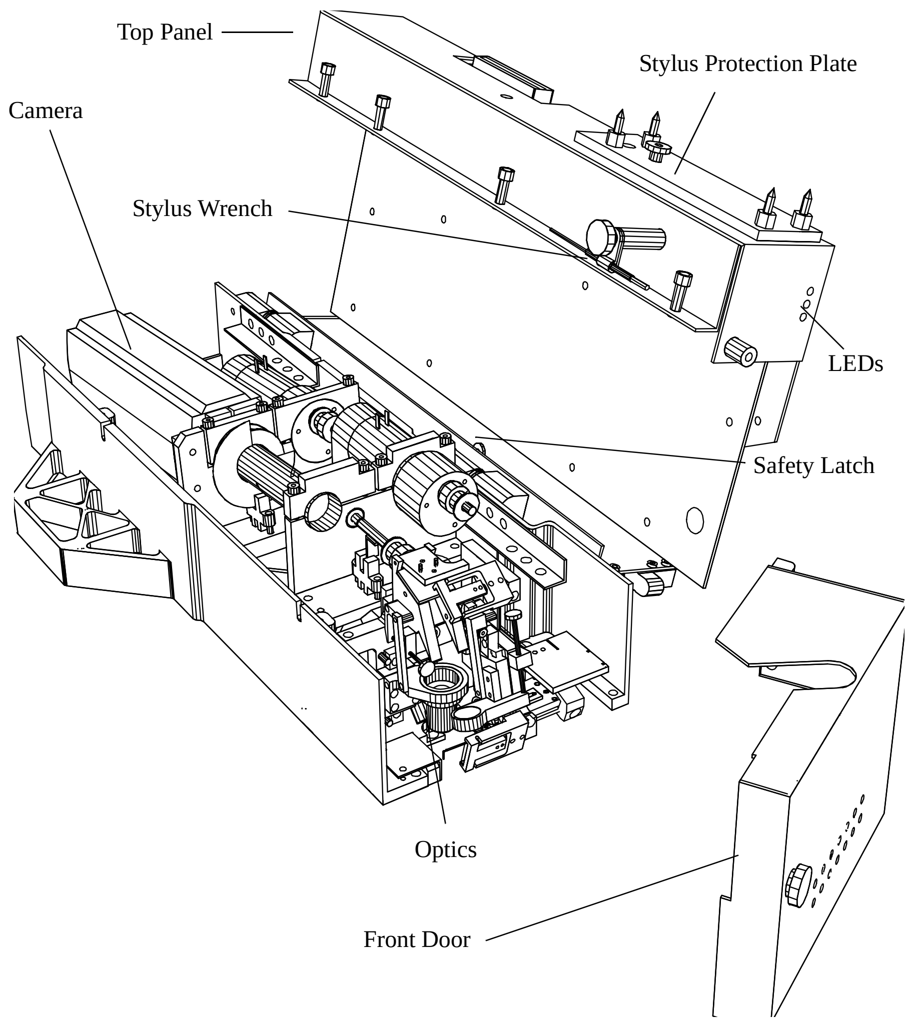
- Roughness, waviness, and roll-off of magnetic and optical disks
- 2-D and 3-D profiles of defects, glide bumps, and special texturing.

See Appendix D, "Specifications" for more details.

MicroHead II Components

The following figure shows the major components of the MicroHead II:

Figure 7-1. *MicroHead II*



The following describes the MicroHead II components.

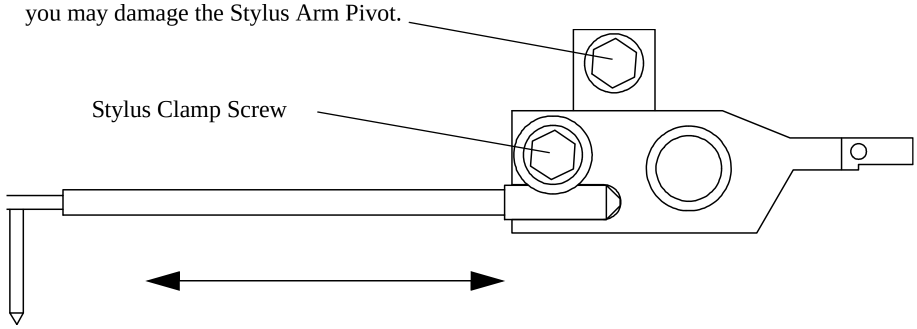
Front Door	To raise the top panel head, you must remove the front door.
Top Panel	The top panel contains the electronics for this head. This door is also removable and contains a safety latch to prevent it from slipping off when it is in the open position.

The Stylus

The MicroHead II includes a stylus wrench, located on the left side of the head. To avoid losing the stylus, should you accidentally drop it during replacement, place a piece of paper, a clean-room wipe, or a small container on the stage beneath the stylus.

Poor performance, and/or questionable data may indicate excessive wear or damage to the stylus.

Figure 7-2. *Replacing the Stylus*



Removing the Stylus

To remove the stylus

1. Raise the measurement head and then open the door.
2. Loosen the thumbscrew holding the stylus wrench on the side of the head and slide the wrench from its holder.

   The head of the stylus clamp screw is visible when you face the instrument.
3. Loosen the screw by inserting the stylus wrench and turning the wrench counter-clockwise by 1/2 turn.
4. Pull the stylus gently to the left and remove it from the stylus arm.

Note: *Be careful to apply turning torque only, do not press inward any harder than necessary to seat the wrench, and do not remove the screw.*

Installing the Stylus

To install the stylus:

1. Insert the long arm of the stylus into the groove in the stylus arm with the tip pointing downward toward the stage.
2. Maneuver the long arm of the stylus gently, but fully, into its slot.
3. Gently tighten the clamp screw to hold the stylus in place. Do not tighten it too much to prevent damaging the stylus arm pivot.
4. Remove the stylus wrench from the stylus clamp screw, return it to its storage clip, and tighten the retaining thumbscrew.
5. Close the measurement head door.
6. Perform the Scan Position Offset calibration procedures shown in *Chapter 5, "Step Height Calibration" on page 8*.
7. Perform the stylus force calibration procedures shown in *Chapter 5, "Measure the Stylus Drop Timer for the MicroHead II head with DCON"*, on page 9.

Changing the Objective Lens

Two lenses are available for the Tencor top view options, offering a range of magnifications, as shown in Table 7-1.

Table 7-1. *Available Objective Lenses*

Lens	Magnification Range	Field Width (mm)
4.0x	185-750x	1.20-0.30
6.3x	300-1200x	0.74-0.18

Note: *Remove the stylus before changing the lens to eliminate the possibility of damaging the stylus by dropping the lens. See "The Stylus" on page 4.*

To change the objective lens:

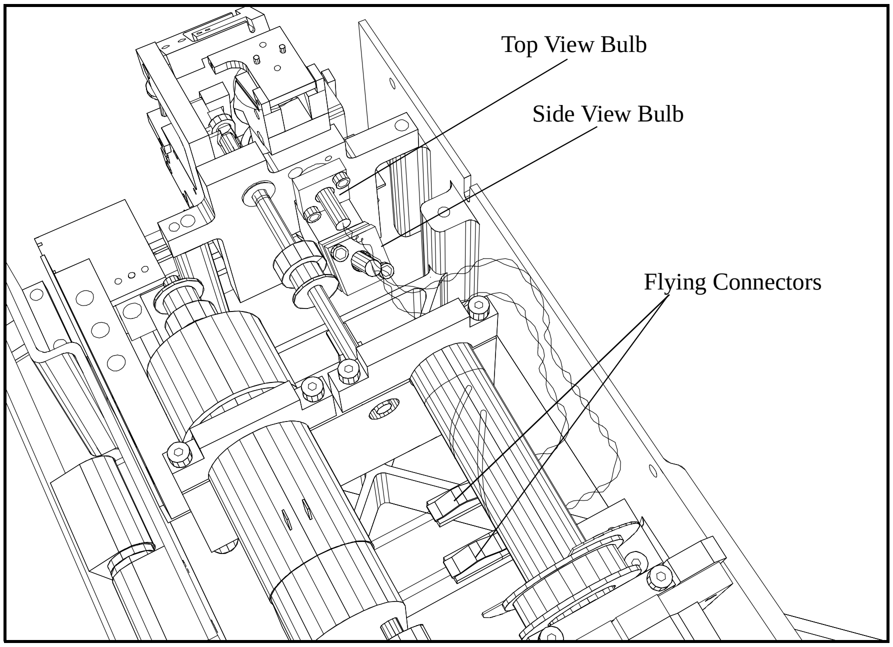
1. Raise the head so that the stylus tip cannot contact any surface.
2. Open the measurement head door.
3. Unscrew the objective lens.
4. Slide it forward to remove it, being very careful not to hit the stylus arm.
5. Screw in the replacement lens.
6. Close the measurement head door.

Note: *Be careful not to drop the objective lens while removing it from the measurement head to avoid damaging the instrument.*

Replacing the Sample Illumination Bulbs

In the back of the optics block are the illumination bulbs for the optics lens (refer to Figure 7-3).

Figure 7-3. *Illumination Bulbs*



The standard optical design provides a top-down view of an image for stylus positioning, as well as the side-angle view for checking the stylus tip and measured features.

To replace the illumination bulbs (For the P-22, omit Steps 1 and 2 and start with Steps3).

1. Remove the instrument left and right side panels.

   Each side panel is held by two large thumbwheel knobs on the inside upper corners. Support the left and right side panel from the outside and unscrew each of the thumbwheel knobs, then gently lift the side panel away from the instrument.
2. Remove the instrument top panel.

   The top panel is held by ten button-head screws, five along each side. Remove the screws with a 3/32 in. hex wrench, then lift the top panel away from the instrument.
3. Lower the measurement head and null the stylus on a patterned substrate.
4. Remove the front door of the measurement head.
5. Loosen the three button-head screws on the left side of the measurement head top panel, then tilt the top panel vertically by using a 1/8 in. hex wrench.
6. Locate the pair of intertwined wires from the illumination bulb at the back of the optics block.
7. Follow the wires to where they are plugged into another cable at a flying connector. Unplug the connector.

8. 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 No. 4 cap-head screws.
9. Use a hex wrench (3/32 in.) to carefully loosen 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, and *do not pull on the wires!*
10. Insert a new illumination bulb. *Do not touch the bulb with your bare fingers*. Do not tighten the cap-head screws yet.
11. Plug the wires of the bulb into the same connector in which the previous bulb’s wires were plugged:
    a. Look at the projected light on the sample surface.
    b. Adjust the position of the top-view bulb until the projected light forms a bright, nearly-perfect circle.
    c. Adjust the side-view bulb by observing the video image on the computer screen.
    d. For either bulb, check the video image with the zoom magnification set to minimum for acceptable quality.
12. Hold the bulb in this position and tighten the cap-head screws on the collet clamp plate.

Setup and Diagnostics

This section describes the setup and the stylus force diagnostic windows.

Measurement Head Setup Window

Use the Measurement Head Setup window to maintain parameters describing physical characteristics of the head, which comes with its own set of calibration values. These numbers are stored in non-volatile memory in the measurement head and on the BACUPCAL diskette.

DOS

To access the Measurement Head Setup window

1. Choose Head Setup from the Calib menu and press the **Enter** key.
2. Press the **F2** key to save the new values.

   To exit without changing the values, press the **F4** key.

Checking the Stylus Force Setup

Use the stylus force calibration window to check for proper stylus calibrations, and if necessary, to re-calibrate. If you change the stylus, you need to re-calibrate the stylus force.

Recalibrate the stylus force:

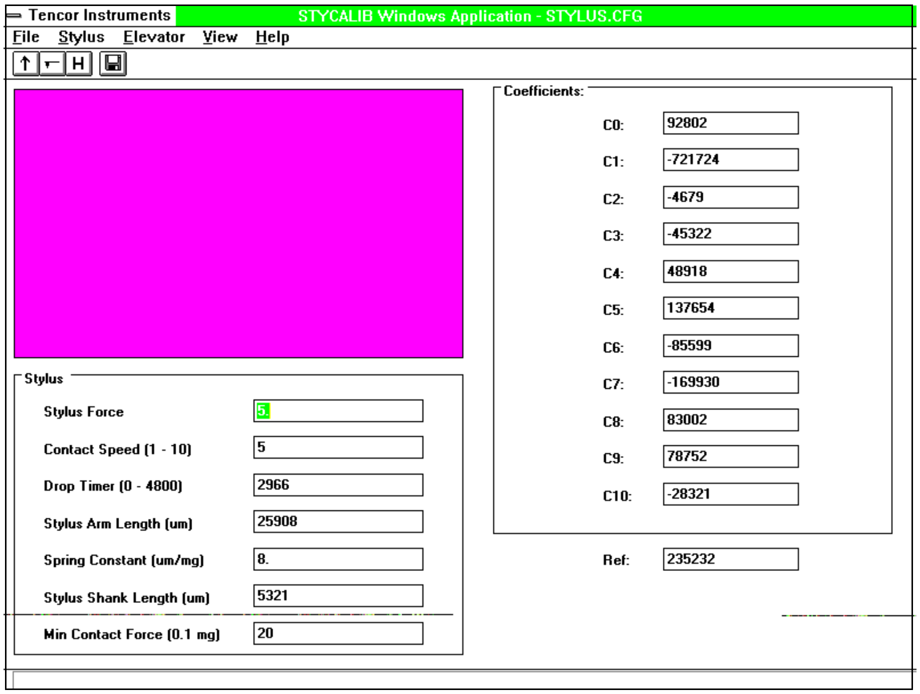
- If you change the stylus.
- If you are using a very low stylus force (less than approximately 1 mg) on samples with a large vertical range (greater than approximately 10 µm).
- If several hours have passed since the last calibration.
- If the room temperature has changed several degrees.

The instrument always performs the calibration when you boot the system.

Windows **To access the stylus force calibration window in Windows Profiler Software, do the following:**

1. Click on the Stylus Force **Calibration Control** button in the Scan Calibrations window. The Stylus Force Calibration window appears:

Figure 7-4. *Stylus Force Calibration Window*



If the stylus is near a sample surface, select Move Up 500 mm or Move To Soft Home from the Elevator menu.

2. Select Calibrate Force Coefficients from the Stylus menu. The stylus force response is calculated and the coefficients C0 to C10 are displayed (refer to Figure 7-4).

   If one of the following is shown, go to DOS, run DCON, and check Force Calibration:

- All of the coefficients are 0, or
- The number 8388608 (or -8388608) appears for any coefficient

3. If neither of the above circumstances apply, choose Save from the File menu to save the new values.

DOS **To access the stylus force calibration window in DOS, do the following:**

1. Select Force Calibration from the Calib menu and press the ENTER key.

   The monitor displays the stylus force calibration window (refer to Figure 7-5).

Figure 7-5. *DSP Force Coefficients (DOS/Windows)*

DSP FORCE COEFFICIENTS		
C[0]	:	0
C[1]	:	0
C[2]	:	0
C[3]	:	0
C[4]	:	0
C[5]	:	0
F1: Save	F2: Set	F4: Quit

2. Press the **F1** key to start a new stylus force calibration.

   If the stylus touches the sample during the calibration, the program asks if you want to raise the elevator, press the **y** key to answer yes.

Note: *The stylus must be free to move through its full range or the calibration fails.*

The monitor displays numbers in the stylus force calibration window mainly for diagnosis with the assistance of a trained service field engineer. The information in this window is useful for verifying the stylus force calibration.

If all of the numbers are zero, or if any number is greater than ± 8,300,000, then the force calibration was unsuccessful or marginal.

Stylus Tip Radius Measurement

This procedure describes a method of inspecting the tip of a stylus to measure its radius or determine if it has been broken. The test is to profile an apex with a radius much smaller than the radius of the stylus tip itself.

Stylus tips are not perfectly spherical; typically the radius varies, being smallest at the tip and larger as the curve flattens out into the shaft. For smaller features, the effective radius of the stylus at the area where the tip contacts the sample surface is smaller than it is for larger features. If the value of “b” in Figure 7-10 on page 7-14 can be chosen as the TIR value of typical measurement, then the actual effective radius of the stylus at that scale can be more precisely stated.

During a scan, the stylus moves in a circular arc around the stylus arm pivot instead of a pure vertical motion. Setting the Arc Correction to ON compensates for the distortion.

If the arc at the apex of the trace is noticeably flattened or misshapen, this could indicate a dull spot in the razor edge, or a broken or misshapen stylus. Try the scan at a few other locations along the razor edge.

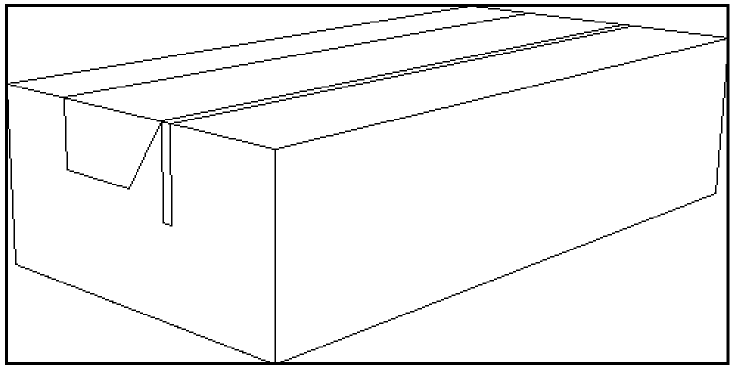
If the apex of the trace appears to be much the same regardless of location along the razor edge, this indicates a flawed stylus.

The Thin Film Step Height Standards have symmetry, and cleanliness stylus integrity test tracks that allow diagnostic checks of the stylus condition. For more information, see the VLSI Standards Application Note “Thin Film Step Height Standard”, provided with the Step Height Standards.

CAUTION: Do not touch the razor edge on the stylus Radius Measurement Tool. To protect the razor edge from any contact with objects other than a stylus, return the tool to its storage case promptly after use. The method of stylus radius determination used is based on assumption that the razor edge has a radius much smaller than the stylus radius. Dulling of the edge invalidates the assumption.

The Tencor stylus radius measurement tool (Tencor P/N 205958) consists of a razor edge mounted in a rectangular fixture, as shown in Figure 7-6 on page 7-12.

Figure 7-6. *Tencor stylus Radius Measurement Tool*



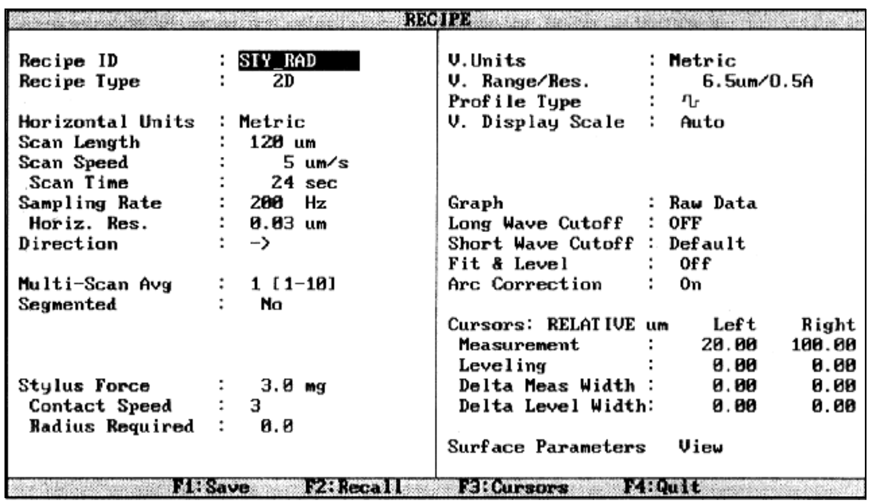
To measure a stylus radius using the stylus Radius Measurement tool

DOS

1. Enter the parameter values in the recipe shown in Figure 7-7:
   a. Verify that the positions of the Left and Right leveling cursors are set to 0 (lower right corner) to disable leveling.
   b. Verify that the measurement cursors have a preset position.
   c. Set the Radius field in the Surface Analysis window to On, or Display.

   If a scan length of 120 µm is too short to effectively make the scan, try: Scan length, 240 µm, Scan speed, 5 µm/s, Samp. Rate, 100 Hz.

Figure 7-7. *Recipe for Determining Stylus Radius*

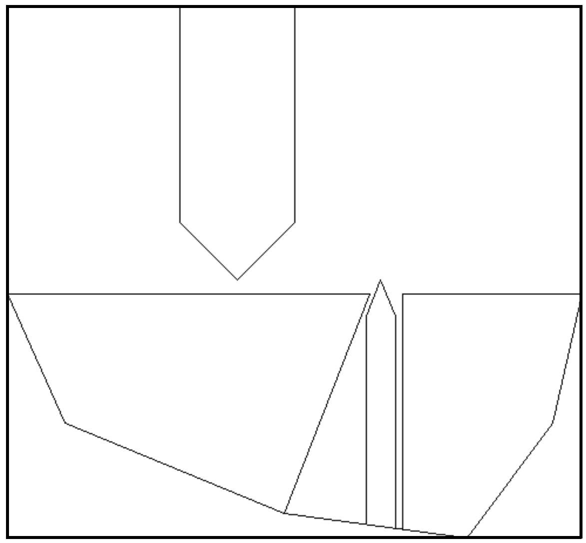


2. Press the **X-Y** or **Z-0** keys to display the Motion screen.

3. Take the scan:

   a. Position the stylus about 50- to 60-µm from the edge of the blade, as shown in Figure 7-8.

Figure 7-8. *Positioning to Start Scan.*



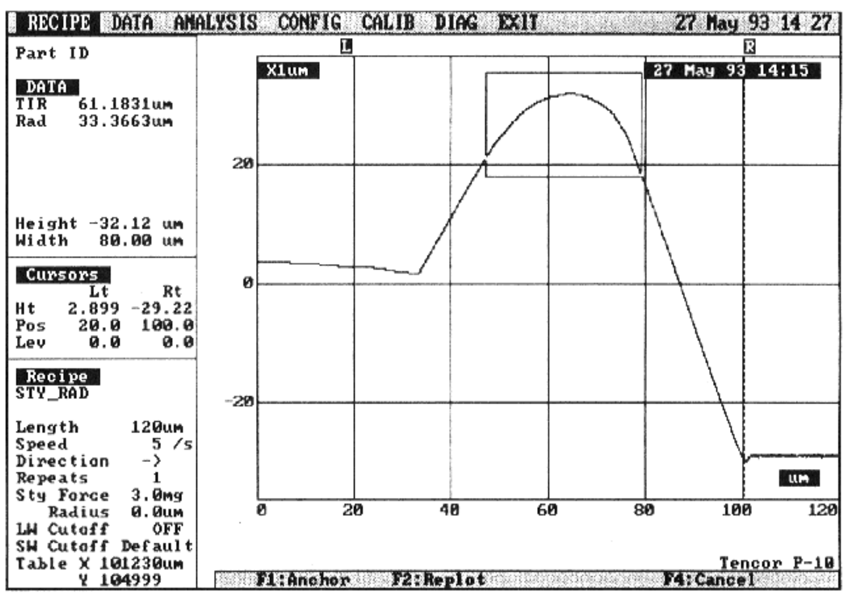
   b. If you cannot accurately determine the position of the edge, take a longer scan to locate the edge.

   c. Adjust the start position accordingly, and return to the shorter scan length.

   d. Null the stylus, and press the **Start** key to take a scan.

   An example of a typical profile is shown in Figure 7-9.

Figure 7-9. *Typical Data Using the Scanning stylus Radius Measurement Tool.*



4. Zoom the trace to the area near the apex and position the measurement cursors on either side, so that:
   - the cursors clearly intersect the trace on the curved portion of the apex, not further away where the trace straightens out.
   - the difference between the cursor height is as close to 0 as possible.

   The height difference should be less than 3% of the measurement width. This is usually the case if the sampling rate is 200Hz and you use *Automatic Cursor Positioning* (set for Apex).

   If you want to adjust the measurement cursors manually, be sure that you have zoomed in the Data screen as much as possible on the region of the apex (refer to Figure 7-9).

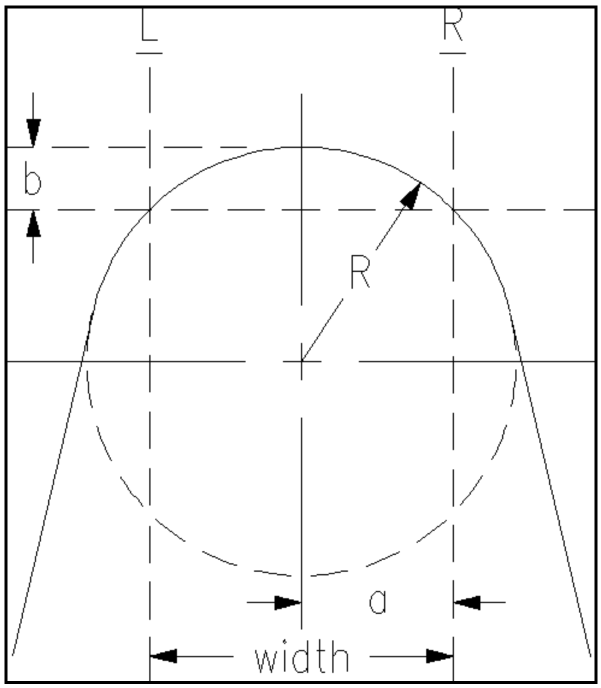


Figure 7-10. *Cursor Positioning for Radius Determination*

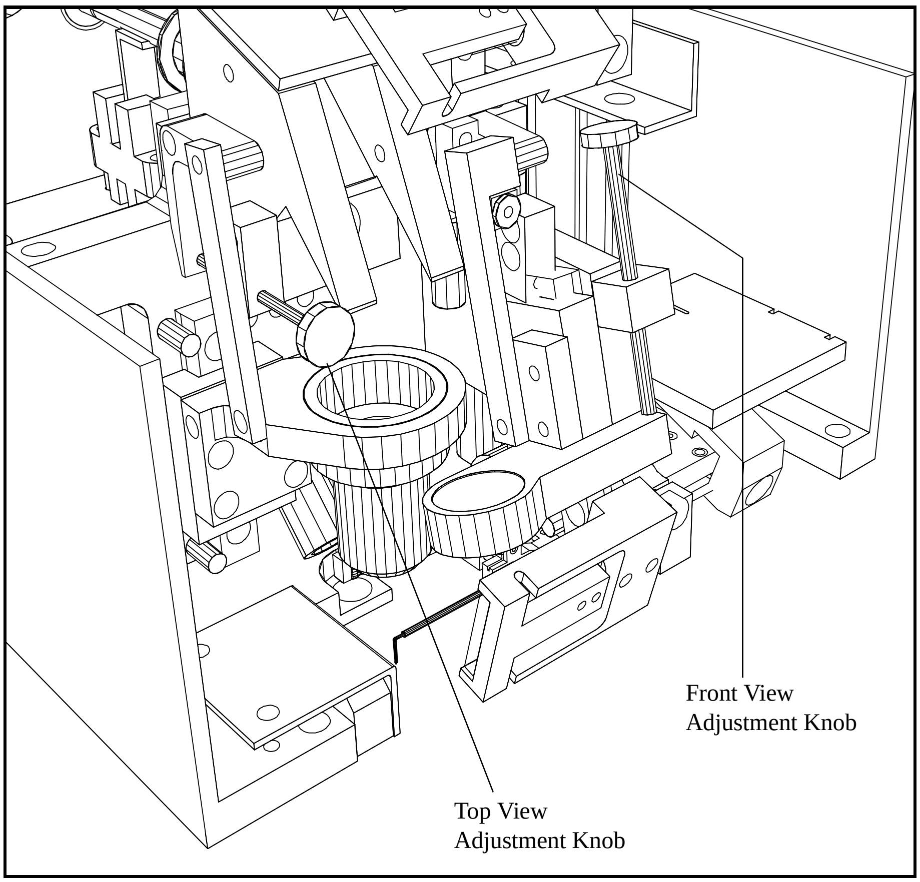
5. Read the Radius value from the summary box in the Data screen.

Focusing the Optics

To focus the optics (refer to Figure 7-11)
(For the P-22, Refer to the P-22 Reference Manual, MicroHead Measurement Head Chapter)

1. Null the stylus on the sample (a patterned sample with easily defined features works well).
2. Locate the two red-capped thumbscrews.
3. Use the first red thumbscrew to adjust the top view.
4. Tap the **up arrow** to lift the stylus without moving the elevator, or wait for 60 seconds so that the stylus is picked up automatically. For dual optics, the stylus must be down.
5. Use the second red thumbscrew to adjust the front view.

Figure 7-11. *Focusing the Optics*



Removing and Installing the Head Assembly

When changing the head assembly:

- Do not discard the special boxes and packaging used to ship the replacement head. Use the boxes and the packaging to return the damaged head to the factory. If the head is not shipped in the special protective boxes, Tencor Instruments is not responsible for any damage to the head during shipment.
- Do not remove the stylus protection plate (refer to Figure 7-13 on page 7-18) on the replacement head until you are instructed to do so.
- Follow the instructions only in the sequence given below.
- Use both hands and carefully hold the head when you remove or install it.

Note: *Head weight is 11 lbs.*

Removing the Head Assembly

Read the instructions completely before attempting the procedures.

You need the following to replace a damaged head:

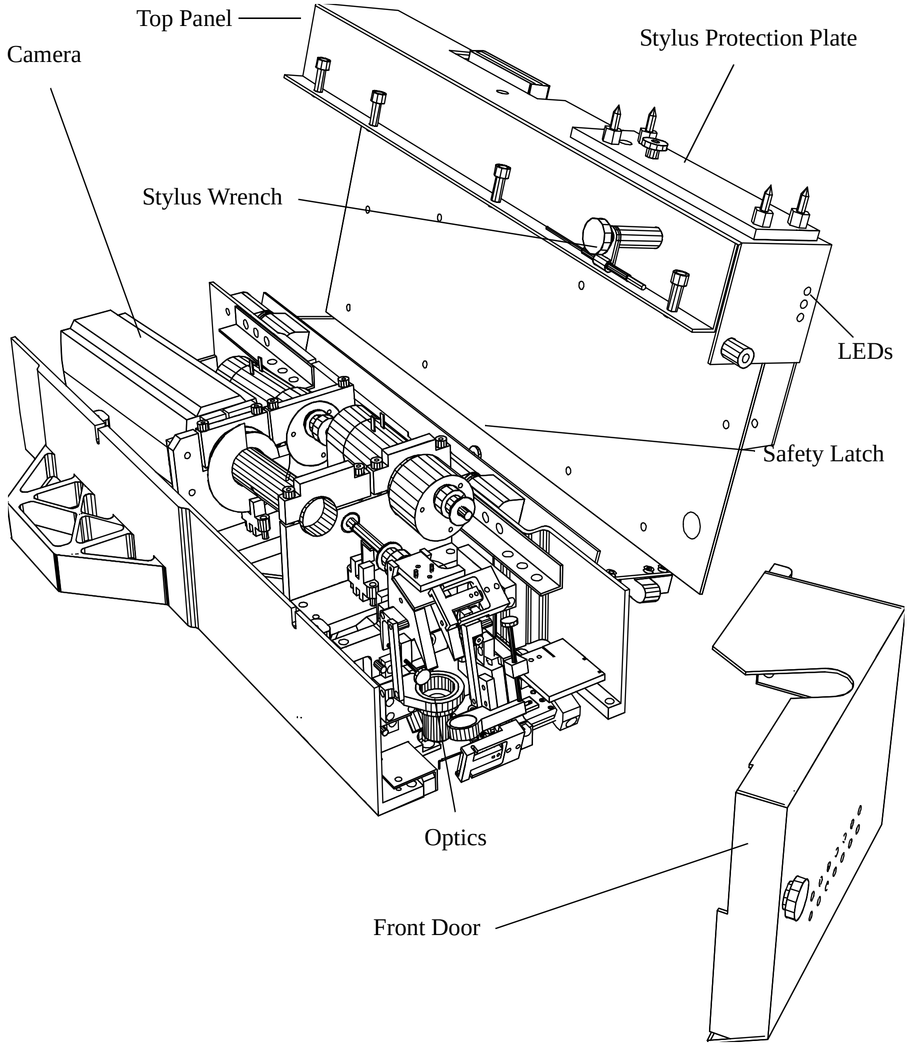
- 3/16 in. hex wrench
- 30 to 40 minutes to remove and replace the head

To remove the head assembly (refer to Figure 7-12 on page 7-17)
(For the P-22, omit steps 1 and 2 and begin at step 3. For more details, refer to the P-22 Reference Manual, MicroHead Measurement Head chapter)

1. Remove both the left and right side panels.

   Each panel is held on by two knobs located inside the instrument near the top front and rear corners.
2. Remove the top of the instrument: using the 3/32 in. hex wrench to remove the ten button headscrews along the top left and right edges of the top panel.
3. Open the front door by loosening and turning the thumbscrew to the right.

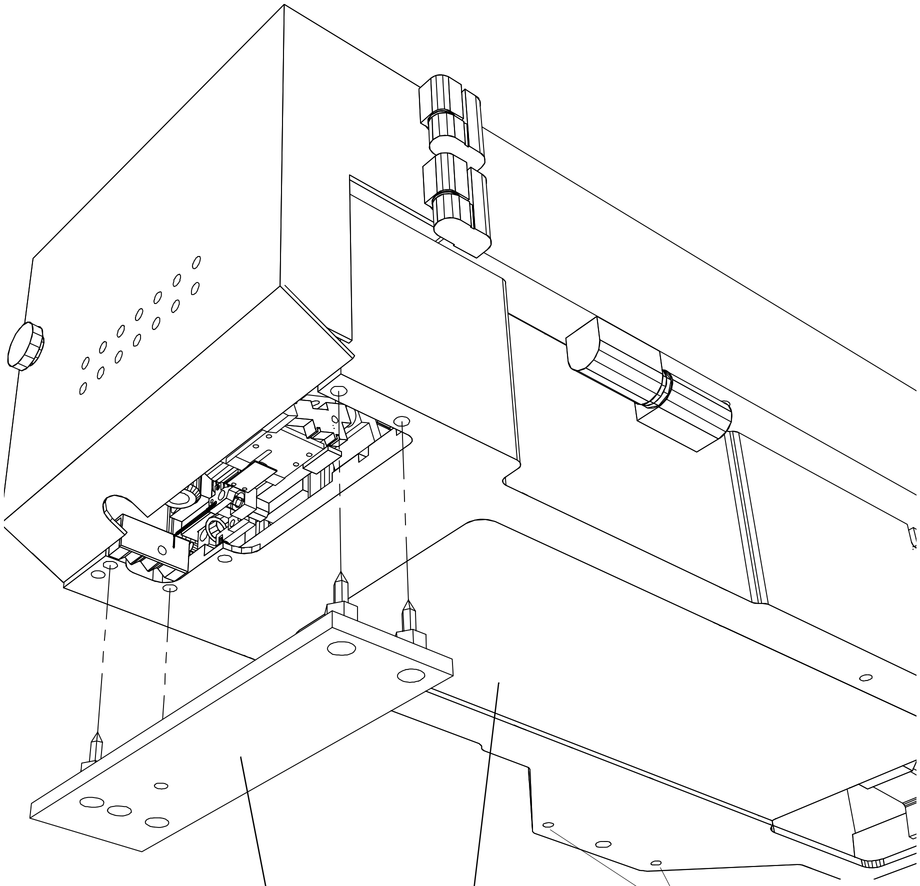
Figure 7-12. *Removing the Head Assembly*



Note: *The white-colored stylus protection plate is stored on the storage screw on the left side of the measurement head*

4. Install the stylus protection plate (refer to Figure 13):
   a. Unscrew the thumb nut holding the plate and remove the plate.
   b. Hold the stylus protection plate with the guide pins facing up.
   c. Insert the guide pins into the holes on the left and right sides of the base plate below the stylus.

Figure 7-13. *Installing the Stylus Protection Plate*



5. Close the front door and tighten the thumbscrew.
6. Lower the measurement head until the head or the stylus protection plate touches the stage table. Note that if the head is damaged, you might not be able to lower the head but you can still remove it.
7. Turn the power off and disconnect the flat cable connected to the head assembly which is located on the left side (on the right side when facing the tool), and the camera BNC cable is located in the back.

   The head is attached to the elevator by four 1/4-20 screws, two on each side of the elevator (refer to Figure 7-13). These screws are accessible through the side panels.

8. Free the head:
   a. Use a 3/16 in. hex wrench to loosen all four screws by a half-turn.
   b. *Do not remove the rear screw on the right side.* This screw supports the head until you are ready to lift the head out.
   c. Remove the remaining three screws.
9. When you are ready to lift the head out, place one hand below the base plate to support the head and remove the last rear screw (refer to Figure 7-13 on page 7-18).

CAUTION: Support the head with both hands.

Note: *On some instruments, you need to disconnect the camera BNC cable in the back.*

10. Lift the head out of the instrument.
11. Return the damaged head to the factory in the same boxes and packaging used to ship the replacement head.

Installing the Head Assembly

Read the instructions completely before attempting the procedures.

Do not discard the special protective shipment boxes and packaging. The damaged head must be shipped in the same boxes and packaging used for the replacement head; otherwise, Tencor Instruments is not responsible for any damage to the head during shipment.

To install the head assembly

1. Unpack the replacement head carefully from its boxes and packaging.

(For the P-22, omit steps 2 and 3)

2. Remove the side panels (if not already removed).

   Each side panel is held by two thumbwheel knobs on the inside upper corners. Support the side panel from the outside and unscrew the thumbwheel knobs, then gently lift the side panel away from the instrument.
3. Remove the top cover of the instrument.
4. Lift the head assembly by its base plate and carefully remove it from its packing container.
5. Install the head assembly:

CAUTION: Support the head with both hands.

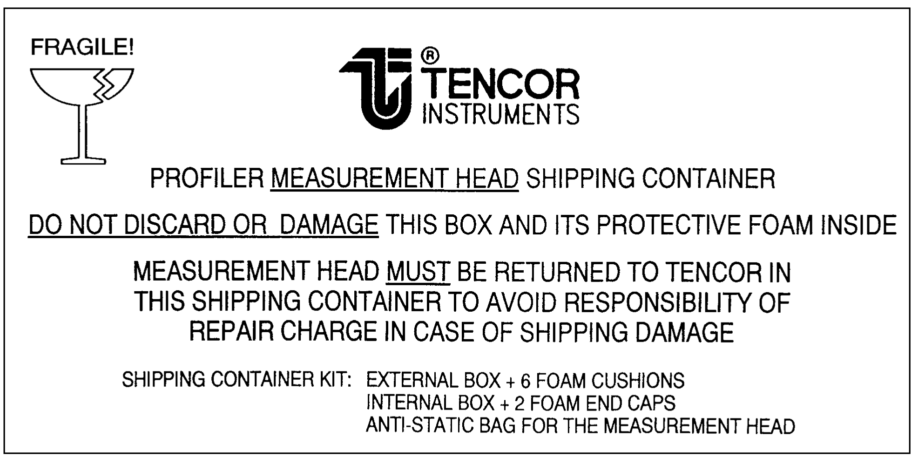
   a. Fit the head assembly snugly over the two head assembly locating pins on the top of the elevator. Use the head alignment labels on either side of the head and elevator to guide the head assembly into its correct position.
   b. Use a 3/16 in. hex wrench to replace the two 1/4-20 in. screws on each side of the elevator.
   c. Tighten the screws to approximately 8 ft./lb.

6. Plug the flat cable into the socket on the left side of the head assembly, (when facing the tool the cable is located on the right side).
7. Attach the camera BNC connector.
8. Remove the stylus protection plate:
    a. Gently apply downward pressure to both ends of the protection plate and remove it.
    b. Store the stylus protection plate under the thumbscrew on the left side of the head.
9. Reinstall the side panels. Place each side panel against the instrument body, support the side panel from the outside, and screw on each of the two thumbwheel screws on the inner side.
10. Turn the power on to the instrument.

Shipping a Damaged Head

Return the damaged head to the factory. Pack the damaged head in the special protective boxes and packaging used to ship the replacement head. The shipping container displays the following label:

Figure 7-14. *Measurement Head Shipping Label*



CAUTION: If the head is not shipped in the special protective boxes, Tencor Instruments is not responsible for any damage to the head during shipping.

8

TROUBLESHOOTING GUIDE

When problems occur, you must find and isolate the failed unit/device. Problems could be caused by:

- Faulty instrument values: try these procedures only for the instrument, and not the computer.
- Computer malfunction.
- A combination of both (e.g., a faulty CPU motherboard can create many different types of errors).

Scan Noise

Scan noise is any scan data deviation from a defined performance specification.The performance specification of the profiler at three specific scan lengths and scan speeds are shown in the following table.

Table 8-1. *Profiler Performance Specifications*

Scan Length	Scan Speed	Stylus Force	TIR Spec
30 mm	2 mm/s	5	300 Å
500 µm	50 µm/s	2	100 Å
35 µm	1 µm/s	2	100 Å

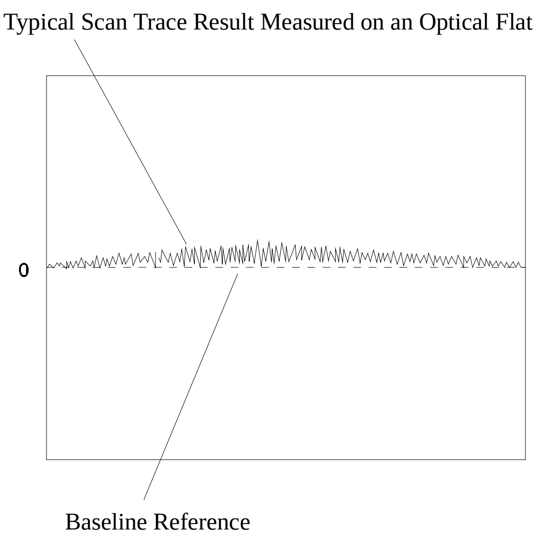
Note: *Tencor verifies the performance of the Profiler by measuring Step Height Standards, and checking for step height repeatability. An optical flat also determines the baseline noise of the instrument.*

Use an optical flat of 1/10 wavelength, a 12.5 µm stylus and in a controlled environment to perform these tests.

The “No-Motion with Null” scan is another diagnostic tool, and can determine if the scan noise problem is associated with the motion system, or the Sensor Arm assembly, or the electronic signal amplification.

The scan data traces in these test scans should exhibit a tight smooth trace without any immediate breaks (refer to Figure 8-1 on page 8-2. Some of these test scan traces will exhibit a bow. This bow is normal as long as it meets the scan noise specification criteria.

Figure 8-1. *Scan Trace Results with Baseline Reference*



Testing for Scan Noise

Scan noise is introduced by many different elements, such as, lead screw, scan motors, stage binding, etc. To identify which component is generating the scan noise, use five different scans to decide which individual component is responsible. These test scans are taken over an optical flat.

Table 8-2. *Scan Trace Noise Solutions*

Problem Element	**Test Scan**
X-Slow Motor or Slow Motor Clutch	Scan trace using the X-Slow motor
X-Fast Motor	Scan trace using the X-Fast motor
Piano wires, Stage Bindings, Lead Screw, or Reference Flat	Scan trace using the X-Slow motor, Scan trace using the X-Fast motor
Sensor Arm assembly or electronics	Scan trace using the X-Slow motor, Scan trace using the X-Fast motor, No-Motion with Null scan
Electronics	Scan trace using the X-Slow motor, Scan trace using the X-Fast motor, No-Motion with Null scan, No-Motion No Null scan with the Sensor Arm assembly disconnected from the Head Electronics PC assembly and a dummy head in its place
Elevator (displays droop in beginning of scan)	No-Motion No Null scan

Scan Track Data

This section describes unusual problems and their solutions.

Note: *Excessive lubricant on the Reference Flat will increase scan noise. Polish and clean the Reference Flat with Tri-Flow lubricant and a clean room cloth.*

When you take scan traces in various locations on the reference Flat and some of these traces show readings that pass the specification only at certain locations, and fail specifications at other locations, try:

- Cleaning the Reference Flat
- Clean the Turcite feet of the X-Carriage assembly.
- Graph the PWM of the X and Y motion axes and check for uniformity.

Table 8-3. *Scan Trace Track Data Solutions*

Scan Trace:	Solution:
Displays an occasional spike, but occurs randomly.	May be due to environment. Take a No-Motion With Null scan using the same Recipe.
Displays a short, tight rolling, hill pattern on a scan trace of an optical flat.	Typically caused by vibration transferred by the environment.
Displays a two-tier step height when measuring a Step Height Standard, that is known to be clean and free of static charge.	Either the Sensor assembly, or its connectors to the Head Electronics PC assembly are faulty.
While scanning a length greater than 1 mm, the trace exhibits a periodic pitch of 1575 µm in length, and the TIR at the height of the pitch is greater than the written specifications.	The X-Drive assembly guide bars and lead screws need alignment. If this fails, replace the lead screw.
When using the X-Slow Motor to take a scan, and the scan trace exhibits a repeatable noise spike.	A fault in the Clutch assembly (if the Clutch assembly is misaligned or faulty, repeatable noise spikes occur in scan traces).

Motion System

There can be many causes to a failure in the motion system. In order to distinguish between a true motion failure and that of an exceeded programmed motion parameter, you must interpret the two types of failure.

A true motion failure involves one of the following:

- Motor failure
- PC assembly, controlling the various motors, failure
- Component failure, i.e. lead screw, coupler nut, etc.

A non-true motion failure involves the setting of parameters invoking restrictions within the motion system. The parameter settings have control over the stylus release, and the travel limits of the “X”,”Y”, and “Z” axes. Table 8-4 on page 8-5 lists the programmable set parameters a user has access to and their controlling functions.

Table 8-4. *Programmable Parameters*

Set Parameter:	Function:
Safety Interlock	Restricts all motor action when either side panels, or front door is open.
Lowest elevator position	Limits the Z downward travel distance to the number set by the operator.
X and Y travel limits	Limits the travel distance of the motorized stage. The set parameters are: MIN: 0, MAX: 210,000.

Motion System Testing

Should a motion axis fail, use the MOTTEST program to independently select each of the six axes for movement.

If the axis selected does not respond to the program command, the problem may be the mechanical component. Check if the drive signal is present at the test points in the Universal Profiler Interface (UPI) PC assembly, and the 4-channel Motor Driver PC assembly. If the drive signal is present to drive the component, but the component does not respond, replace the faulty component.

If the motion axis failure is an intermittent fault, use the MOTTEST program to graph the PWM of all the axes of the motion system. Look for a consistent power consumption at around 80% or lower. Also, test the limit switches for continuity.

If the motion axis failure error is continuous even during system initialization, check the red LED on the UPI board to see if it is blinking rapidly (the CPU acknowledges the interrupt line for that board). Check that the 2 MHz clock is present for the motor driver integrated circuits. If the 2 MHz clock is present and the red LED on the UPI board is blinking, see at which phase of the initialization sequence the motion failure occurs. Cross reference with the “Error Code Chart” to isolate the problem. Note that the Limit and Home switches can provide error messages and code.

Scanner Box Interface PC Assembly (P/N 231703)

From the Scanner Box Interface card to the UPI board, you can measure power supply voltages to the scanner portion of the profiler at the following locations:

Table 8-5. *Scanner Box Interface Card Test Points*

Test Point:	Description:
9	+12 V for the DC motors
8	Ground reference for the +12 V to the DC motor
10	-12 V for ICs
6	+12 V for ICs and the DC to DC converter
11	+5 V for TTL devices
7 and 2	Digital ground
4	+15 V to the Head Electronics card
3	-15 V to the Head Electronics card
5	Analog ground

The Keylock, Interlock, and Handler Door connectors are connected to J14, J15, and J13 respectively.

You can monitor the “PWM” and “Sign” signals coming from the UPI board to drive the various DC motors at Tp 1 pins 1-16. Reference the schematic drawing for pin location.

4-Channel Motor Driver PC Assembly (P/N 242392)

The following tables describe “Signal” to “Test Point” of the 4-Channel motor.

Table 8-6. *4-Channel Motor Driver Test Points*

Motor:	Signal:	Test Point:
X-Slow	Direction	1
	PWM	2
X-Fast	Direction	4
	PWM	7
Z	Direction	9
	PWM	11
Y	Direction	13
	PWM	16

The following table describe “Signal” to “Test Point” of the 2-Channel motor.

Table 8-7. *2-Channel Motor Driver Test Points*

Motor:	Signal:	Test Point:
Theta	Direction	1
	PWM	2
Level	Direction	4
	PWM	7

Error Messages

Interlock Switches

If the instrument Interlock Switches are enabled through Config in the Setting menu, an open side panel or front door will disable the motion system. This means the Sensor Arm assembly will not lower down but toggle up and down repetitively, and the Measurement Stage remains dormant.

True Motion Error Axis Failure

This is a problem in the motion system, drive assembly, limit and home switches, or the electronics supporting the motion system. If the motion system fails to move to a pre-programmed destination, such as the load and unload position of the measurement stage, check the operator program travel limits setting.

True Motion Error Limits Exceeded

This error occurs when the motion system tries to execute the programmed movement, thus stopping all motion in the system.

Sample Surface Too High

This message occurs when either the center vane of the Sensor Arm assembly is already above null when trying to null on the test sample, or if the descent rate of the Sensor Arm assembly is not smooth and jerks the center vane above the null position.

In either case, the elevator moves the Measurement Head upward in incremental steps. If the Measurement Head is far above the test sample when you press the **down arrow** key, and the screen displays this message while the elevator continues to move upward, press the **Stop** key to halt the present sequential actions.

At this point, there are two possible problems:

- The descent rate of the Sensor Arm assembly is not smooth, causing the center vane to bounce above null which requires finding a different “Stylus Drop Timer” number, or realigning of the Lifter Motor Tension Spring.
- The test sample has a charge to it pushing the center vane above null when the Sensor Arm assembly is being released.

Remove the test sample from the measurement stage and lower the Sensor Arm assembly by toggling the **down arrow** key.

If the “Sample Surface Too High” message still displays, the descent rate needs alignment. If the same message does not display. the test sample material has too much electrostatic force.

Software Problems

Corruption of the software, or Security Key makes the instrument inoperative. Below are typical software error symptoms or messages:

- You cannot import or export certain or all database files.
- You cannot access specific records in the Recipe, Sequence, or Database management files.
- The screen displays a “Stack Overflow” message.
- The screen displays a “Run Time Error” message.
- The screen displays an “Internal Database Error” message.

Database Corruption

The Database consists of information added (i.e. Recipes, Sequences, scan trace data) to the operating software. Database corruption only affects the database and can only be removed by deleting the faulty record(s) and closing the file.

A Record that is not retrievable or executable is a faulty record. A sure solution to correct the problem of database corruption is to delete the entire database.

If a backup copy of the database was created after the corruption occurred, restoring these files will most likely re-create the corruption. Should you restore the backup copy of the corrupted database, it will fail as data is stored and manipulated.

To delete the entire database in DOS:

1. Exit the instrument into the \TENCOR directory in DOS:
2. Type: Deletedb.bat to delete the database and press the **Enter** key.
3. Create a backup copy of the Recipes and Sequences.
4. To create entire database in windows, you can delete the files in the sequence database by typing initdb_seq in /orcal.db. You can delete the files in the recipe database by typing initdb-rep in local/db.

Software Corruption

Software corruption occurs within the Profiler operation software, and affects the ability of the system to execute commands from the keyboard or keypad.

CAUTION: Do not misinterpret the term “software corruption” with every non-performing “depressed key” to functional execution. Settings in the menu configuration affect the performance of the instrument.

Database and/or software corruption occurs if a recipe, a sequence, and/or data record is in a processing routine and the instrument is reset before the routine is finishes.

CAUTION: Resetting the instrument prematurely, especially when the green disk light is on, causes fragmentation of the database/software.

Software corruption has many causes, for example:

- An incorrect CMOS Setup configuration.
- Software utilities that compact files, or speed up data processing.
- The Hard Disk is filled to 90% of its maximum capacity, corruption can occur leaving too little memory available.
- New bad clusters on the hard disk containing portions of the Profiler operating software or database can also cause the instrument to fail.

DOS **To correct a software corruption problem, reformat the Hard Disk and reinstall the Profiler operating software**

1. Put the system disk into the drive A.

   This is a 3.5" floppy system disk with IBM DOS version 5.0 or newer.
2. Reset the instrument.

   The instrument should boot from drive A.
3. Press the ENTER key at the Time prompt.
4. Press the ENTER key at the Date prompt.

   The screen displays the A:> prompt.
5. Type FORMAT C:/S and press the ENTER key.

   The system formats the drive C. You do not need to re-partition the hard disk.

Software Loading, The Security Key

The electronic Security Key verifies that the instrument is loading the authorized software package. If the Key is faulty, it can stop the instrument from booting. A faulty electronic Security Key displays the following problems:

- Inability to install system operating software.
- Restricted progression to initialization of the instrument after a restart (the initialization screen is missing the Serial Number, and the options installed in the instrument).

To correct a Security Key problem, the software package originally shipped with the instrument or an upgrade package must have the same matching Serial Number of the instrument on which it is to be installed.

The instrument only restricts software installation in the following cases:

- The software serial number labeled on the diskette does not match the serial number of the instrument (the label in the rear next to the cable connectors).
- Faulty Electronic Security Key.
- Faulty software (missing or bad files within the diskette).

Missing Overlay File Error

A “**Missing Overlay File**” error message occurs when the installed software is missing, or can not find a file.

If the instrument was recently upgraded with a new Hard Disk and Disk Controller PC assembly, the CPU BIOS may require an update that matches the hardware configuration.

Computer Problems

Consult your MS-DOS User's guide for more information.

Known problems include an incorrect computer system configuration, or a hardware failure when the computer fails to boot. These are problems with the hardware, or firmware (BIOS), and are not related to the software.

Sometimes, a brownout (low power line voltage) occurs, and causes the computer to reset, or run erratically. In a brownout, the line voltage to the computer will measure below 105 VAC. (Normal VAC is between 105 and 135 VAC.)

A normal reset causes the computer to beep once and the monitor displays the CMOS tests followed by the computer configuration. If the CMOS Memory Count option is enabled, the computer produces a "ticking" sound as its tests memory. When the test finishes, the computer accesses either the hard drive or the drive A: for the system files.

The "Memory Test Tick Sound" should be audible and determines if the CPU motherboard is working properly after a reset or after you turn the power on, (even without a monitor display).

The following sections presume that the power supply of the computer is good and that the Memory Count option in the CMOS Advanced Setup is enabled.

CMOS and Extended CMOS Setup Corruption

When the Extended CMOS Setup is incorrect, the processing time of the CPU may increase. The monitor may also show a CMOS Setup error message.

Appendix C, "PC Bios Setup" lists three computer Extended CMOS Setup configurations. If the normal CMOS setup is incorrect, the computer may have difficulty booting, if at all. Refer to the section documenting the CPU motherboard for proper system configuration.

Monitor Screen is Blank On System Boot

The CMOS Advanced Setup contains an option to enable Memory count. When this option is enabled (usual configuration), the computer makes a "ticking" sound during the boot process.

For these problems, try the following:

- Connect the monitor cable connector directly to the VGA card and reset the instrument.
- At boot, if the monitor screen is blank, the floppy disk drive is inactive, the power supply is good, and there is no "ticking" sound, replace the CPU motherboard.
- If there is a "ticking" sound and the monitor is blank, check for bent or missing pins on the monitor connector interfaced to the VGA card. The problem could be the VGA card or the monitor.

Disk Controller, Floppy and Hard Disk Drives

Connect the monitor cable connector directly to the VGA card and reset the instrument. If the computer does not beep, this indicates a problem with the disk controller or floppy disk drive.

If the system does not boot up from the Hard Disk drive, do one of the following:

- Reset the system and check the CMOS setup, it should match the configuration of the computer.
- Put the system disk in the drive A and reset the computer. Once the computer boots from the drive A, try to access the drive C. If this fails, the problem could be a bad hard disk drive, or a bad disk controller.
- Replace the disk controller and boot the computer. If the failure continues, replace the hard disk and re-install the disk controller.

Sometimes, and only as a last resort, reformatting the hard disk drive corrects the problem. Common problems with the hard disk are shown in the following table.

Table 8-8. *Hard Disk Solutions*

Problem	Description	Solution
File fragmentation	File fragmentation increases the time it takes for the hard disk to read and write. Fragmentation occurs when files of different sizes are removed and added.	Optimize the hard disk with the DOS “DEFRAG” command, or use Norton Utilities.
Cannot access the drive during a reset or boot	Boot sectors on the hard disk are corrupt. The “FDISK” DOS command formats the hard drive and restores the boot sectors.	Use “FDISK” to format the new disk.
Complete failure of the electronics and the disk	If the hard disk has a complete failure, you must replace the hard disk, and format the new disk. No low level formatting is required for an IDE hard disk.	Use “FDISK” to format the new disk.

Reformatting the 850 Mbyte Hard Disk

You need the following tools: 3.5" floppy system disk with IBM DOS version 5.0 or newer.

To reformat the hard disk drive

1. Put the system disk into drive A.
2. Reset the instrument.

   The instrument boots from the drive A.
3. Press the ENTER key at the Time prompt.
4. Press the ENTER key at the Date prompt.

The screen displays the A: prompt.

5. Type FORMAT C:/S and press the ENTER key.

   The system formats the drive C: (the /s copies system files from drive A to the hard disk drive C). You do not need to re-partition the hard disk.

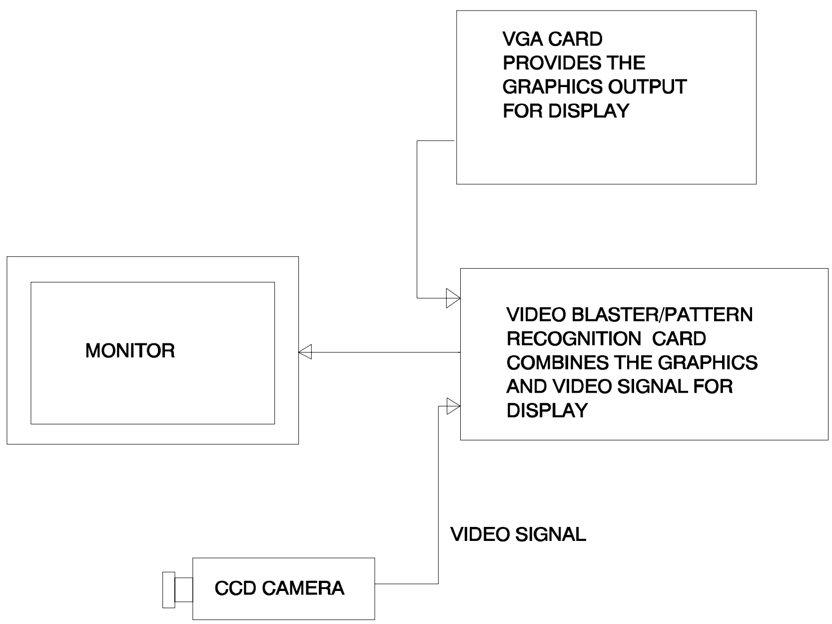
Graphics and Video

The following elements control the graphics and video portion of the Profiler:

- VGA board generates the graphics display on the CRT screen
- Video Blaster card combines the signals from the VGA and the video signals from the camera and channels it to the SVGA monitor for display
- Camera
- SVGA monitor
- Auto iris circuitry in the Head Electronics card

The illumination required for the camera to operate properly is controlled through the auto iris circuitry upon the feedback received from the camera. The lamp intensity changes based on the feedback signal from the camera.

Figure 8-2. *Graphics/Video Signal Path Block Diagram*



If both the graphics and video images are unsatisfactory, connect the monitor cable directly into the VGA card. If the graphics display is satisfactory upon rerouting the information signal, replace the Video Blaster card. If the problem persists, replace the VGA card.

System Initialization Error Codes

The “Error Codes: are incorporated as part of the graphic display upon system unitization. This provides the means to analyze a fault if a problem should occur within one of the axis. The error codes are displayed in the order drawn in the Table 8-9, below.

Example:

After pressing the Enter key to initialize the system, the video screen displays a red box identifying an initialization failure message. The error code printed in this message is: 011111. From Table 8-9, this error code message states the failure is in the X-Fast Scan Axis

Table 8-9. *Error Code Chart*

	X-Fast	Y	Z	X-Slow	Theta	Level
All Axis OK	1	1	1	1	1	1
Manual Stage OK	0	0	1	1	0	0
Motorized Stage OK	1	1	1	1	0	0
X-Slow Axis Failure	1	1	1	0	X	X
X-Fast Axis Failure	0	1	1	1	X	X
Y Axis Failure	1	0	1	1	X	X
Z Axis Failure	1	1	0	1	X	X

Key

0 = Did not reach home

1 = Homed OK

X = Don’t care (can be 0 or 1)

9

DIAGNOSTIC DISKETTE

The Customer Support Diagnostic Diskette provides supporting software to thoroughly examine the motion system of the Profiler (refer to the following table).

CAUTION: Using this software incorrectly can induce problems within the Profiler motion system.

Table 9-1. *The Diagnostic Files*

Name	Description
COPYA2C.EXE	Copies files from the diagnostic diskette to the drive C.
`MOTTEST.EXE`	Lets you move and graph functions of individual axes of the motion system.
`BURNIN.EXE`	Lets you move individual, selected, or all motion axes for testing or post repair burn-in of the motion system.
DELSPEC.EXE	Use to delete files from the drive C that were copied using the COPYA2C.EXE program.

MOTTEST.EXE

The `MOTTEST.EXE` file allows the user to independently select a particular motor to test for problem identification.

This test is most helpful in determining if a particular motor function is not operating, or if the Turcite Pads of the X-Carriage Assembly need lubrication, or adjustments.

If a motion axis is not accessible for testing, the instrument may have a fault within the Universal Profiler Interface or Motor Driver PC assemblies.

To run the `MOTTEST` program in the WINDOWS Software

Note: *With Windows Software, you should be in the directory, c:\orca\syscfg.*

1. Copy `MOTTEST.EXE` from:

   c:\orca\syscfg to:

   c:\windows
2. Exit Windows
3. From c:\windows type `MOTTEST`

Must be sure that MOTTEST is in the windows directory. This is where the motion data files are located:

```
(xfast.dat, y.dat, z.datm level.dat, xslow.dat, theta.dat
and mot_cfg.dat)
```

DOS

To run the MOTTEST program (DOS Software)

1. Exit the instrument back into DOS and into the Tencor directory.
2. Insert the Customer Support Diagnostic Disk into drive A of the instrument.
3. Access the drive A.
4. Type COPYA2C and press the ENTER key to run this program.

   The MOTTEST file is transferred to the Tencor directory of the drive C.
5. Access the drive C.

   You should be in the Tencor directory on the drive C.
6. Type MOTTEST and press the ENTER key to run this program.

   The monitor displays the following request:

   ```
   Axes configured:
   Enter 1 for EGA, 2 for CGA, 3 for Hercules
   ```
7. Enter 1 (for EGA) and press the ENTER key to run this program.
8. Use the **up** or **down** arrow keys to highlight the parameter that you need to access.
9. Use the **space bar** to select the various motion axes options available.

   MOTTEST updates the values of the recorded parameters values to the axis of motion shown on the monitor.
10. To establish a reference home position:
    - a. Select an axis.
      - Select INITIALIZE
      - F1 to EXECUTE
    - b. Select “Go Home” in the CMD line.
    - c. Press **F1** to execute the command

Note: *Not all motion axes options in MOTTEST are used in the Tencor Profilers. This particular software is also used in other Tencor products.*

Note: *To exit MOTTEST press [Ctrl] [Home].*

If you wish to do a “graphing,” select an available option (i.e., velocity, PWM, or position) and the length of graph time. Press the **F1** key to execute the command.

Note: *The travel limits of that particular motor is limited by the “-limit” and the “+ limit” set at the bottom of the menu.*

If you select a “move distance” or” move position” on the “cmd” line, enter the distance or position you would like the particular motor to move. Press the **F1** key to execute the command.

The “status” parameter will identify the present status of the motor, and display messages shown in the following table:

Table 9-2. *Motor Status Message Descriptions*

Status Message	Description
Idle	Motor is not moving.

Table 9-2. *Motor Status Message Descriptions*

Status Message	**Description**
Hold	Motor has moved to its final programmed destination.
Active	Motor is moving.

When the motor is running, the “position” parameter changes corresponding with the rotation of the motor in reference to its home position. The final “position” number will be close to the programmed destination you entered.

The monitor displays the motion parameters menu:

Table 9-3. *Motion Parameters*

Parameter	**Motion Parameters**
Axis	Select the motor to test: press the **space bar** and press ENTER key.
Cmd	First initialize, then home before selecting another command function.
Graphing	Select PWM which allows you to view the amount of power required to move the particular motor.
For	Enter the length of graph time.
Status	Identify the present status of the particular axis motor in question.
Position	Identifies the present location of the stage.
Low gain	Do not touch. Affects the motor feedback gain control.
High gain	Do not touch. Affects the motor feedback gain control.
Zero	Do not touch. Affects the motor frequency response control.
Pole	Do not touch. Affects the motor frequency response control.
Timer	Do not touch. Sample rate of motor by quadrature encoder reader/controller.
Max pwm	Do not touch. Set maximum Pulse Width Modulation level to drive the particular motor.
Pwm count	Do not touch. Maximum amount of times the PWM may exceed the max PWM value before motor power shutdown.
F1: Execute F3: Stop F5: Resume F7: Save File F9: Em Stop All	

Table 9-3. *Motion Parameters*

Parameter	Motion Parameters
Dist/pos	Enter to move a specific distance or position of the stage.
Max vel	Do not touch. Affects the velocity of the particular motor being driven.
Integ vel	Do not touch. Controls the velocity of the particular motor being driven. If set to 0, the motor does not move, even when initializing to home the axis.
Accel	Do not touch. Controls the maximum acceleration of the motor.
Move pwm	Enter a number here to tell the motor controller and motor driver PC assemblies to provide a continuous pulse width modulation level to the particular motor.
Soft home	Do not touch.
Aux word	Do not touch.
- limit	Negative travel limits of the particular motor.
+ limit	Positive travel limits of the particular motor.
Home dir	Do not touch.
Virt dir	Do not touch.
Home vel	Do not touch.
Home acc	Do not touch.
F1: Execute F3: Stop F5: Resume F7: Save File F9: Em Stop All	

BURNIN.EXE

This program lets you move and test the individual axis of the motion system to determine if there is a problem, and also tests for the ability to burn-in the motion system after you complete a repair.

The `BURNIN` program does not have diagnostic messages to identify why a particular motion axis has failed.

DOS

To run the `BURNIN.EXE` program with DOS version of Software:

1. Exit the instrument back into DOS and into the Tencor directory.
2. Insert the Customer Support Diagnostic Disk into drive A.
3. Access the drive A.
4. Type COPYA2C and press the ENTER key to run this program.
   The BURNIN file is transferred to the Tencor directory of the drive C.
5. Access the drive C.
   You should be in the Tencor directory on the drive C.
6. Type BURNIN and press the ENTER key to run this program.
   The monitor displays the BURNIN menu.

Note: *To exit* `MOTTEST` *press [Ctrl] [Home].*

To run the `BURNIN.EXE` program with WINDOWS version of Software:

Note: *Must change in the config.sys file before* `BURNIN` *can be run.*

1. Find the line
   REM DEVICE=c:\dos\emm3bg.exe.
2. Delete the REM, save the file and reset the unit.
3. Copy `BURNIN.EXE` from c:\orca\syscfg to c:\windows. Burnin must run from the sThe highlighted menu box shows which particular axis is chosen for test. Command options are listed at the bottom of the six motion axis boxes. The motion axis must be “home,” before it can be burned-in.

To exit from the `BURNIN` menu, press the ESC key.

CAUTION: Do not execute the BURNIN **program on the “Z” axis with locators, fixtures, or large substrates mounted on the measurement stage.**

If the motor cannot perform, the monitor displays an error message at the bottom of the menu. You have to determine what is causing this particular problem. There are two motion error messages normally displayed on the screen when a true motion error occurs:

Motion error axis failure

Motion error limits exceeded

If these messages appear, look for a possible problem in the motion system, drive assembly, limit and home switches, and the electronics supporting the motion system.

Questions you should ask are:

- How can I isolate and identify what is causing the problem?

  Should a motion axis fail, determine which axis has failed by using the MOTTEST program to independently select each of the six axes for movement. See MOTTEST.EXE on page 9-1.
- Is it a problem with the motor?

  If the axis selected does not respond to the program command, determine if the problem lies in the mechanical component by checking if the drive signal is present at the test points in the Universal Profiler Interface (UPI) PC assembly, the 4-channel motor driver PC assembly, and the X-distribution PC assembly. If the drive signal is present to drive the component, but the component does not respond, replace the faulty component.
- Is it a problem with the Universal Profiler Interface PC Assembly?

  If the motion axis failure error is continuous, even upon system initialization, check the red LED on the UPI board to see if it is blinking rapidly (which indicates that the board's interrupt line is being acknowledged by the CPU). Also, check if the 2 MHz clock for the motor driver ICs is present. If the 2 MHz clock is present and the red LED on the UPI board is blinking, determine at which phase of the initialization sequence the motion failure occurs.
- Is it a problem with the Motor Driver PC Assembly?

  If there was component failure within one of the motion boards, first determine which motion axis fails to work. This can be done by simply initializing and homing the individual axes one at a time with MOTTEST.

  The axis that fails normally fails during the initialization and home sequence due to a loss of communication and feedback information between the motor driver IC and the motor encoder. Once that failed motion axis is identified, then run MOTTEST again to determine if the same motion axis fails. If the same motion axis fails, the problem lies in the UPI card. If a different motion axis fails, the problem lies in the 4-channel motor driver card just swapped. This assumes that e X-distribution card and communication cables are fine.
- Is it a lubrication and binding problem?

  If the motion axis failure is an intermittent fault, use the MOTTEST program to graph the PWM of all the axes of the motion system. Look for a consistent power consumption at around the 80% level.
- Is it a problem with the limit switches?

  Check the limit switches for continuity. If the motion system fails to move to a pre-programmed destination (for example, the load position of the measurement stage), check the programmed travel limits setting. If the programmed destination is outside the set travel limits, the system will not drive the stage there.

Graphing the PWM of the motion system can help determine if the lead screw of the particular motion axis needs lubrication. The PWM value normally runs at around 80%.

The set parameter values for the individual axis are listed in Table .

Table 9-4. *Individual Axis Set Parameters*

	X-Fast	**Y**	**Z**	**X-Slow**	**Theta**	**Level**
Lo-Gain	30	30	15	3	15	7
Hi-Gain	30	30	15	3	15	18
Zero	231	231	231	200	200	205
Pole	128	128	128	100	80	128
Timer	35	35	35	255	60	100
Max. PWM	110	110	110	110	110	80
PWM Count	2	2	2	2	2	2
Dis./Pos.						
Max. Vel.	20	20	20	15	25	10
Integ. Vel.	20	20	0	15	25	10
Prop. Vel.	20	20	0	15	10	10
Accel.	10	10	50	90	8	10
Mov.						
Soft Home						
Aux. Word						
- Limit	-266000	-266000	-215000	-4000000	-4000000	-15800

Table 9-4. *Individual Axis Set Parameters*

	X-Fast	Y	Z	X-Slow	Theta	Level
+ Limit	266000	266000	2000	4000000	4000000	15800
Home Dir	Forward	Reverse	Forward	Reverse	Forward	Reverse
Virt. Dir.	Inverted	Inverted	Inverted	Inverted	True	True
Home Vel.	15	15	30	0	15	0
Home Acc.	5	5	20	0	5	0

If you change a parameter, you must lock in the new value:

1. Press the **F7** key to save the file.
2. Press the CNTL-**Home** keys at the same time to exit
3. Press the RESET key to lock in the new value to the motor configuration file.

A

Preventative Maintenance Schedule

In order to maintain performance of the Profiler, attend to the following maintenance schedule (also refer to the Reference Manual):

Weekly

1. Check the quality of the stylus.
2. If the stylus has been replaced, update the stylus offset reading for a correct and consistent reading.
3. Check the Hard disk capacity to make sure it is less than 90% full.
4. Check the stylus force calibration.

Monthly

1. Check step height calibration.
2. Check the Power Supply voltage levels (see PM Checklist).

Quarterly

1. Check scan noise performance using an optical flat (1/10 wavelength) with written specifications. Make the necessary adjustments to achieve the specifications, if components are not overly worn
2. Check the system Database. Use the CHECKDB program found in the DOS:Tencor: directory.
3. Check the PWM of all motion systems (See DCON). Clean and lubricate the X and Y lead screw. Clean and lubricate the Reference Flat.

Semi-Annual

1. Check all cables. Look for fraying and test for poor connection by wiggling each cable.
2. Check all printed circuit boards. Look for discoloration, and note each instance as possible failure in the future.
3. Check resistance of the limit switch FUNCTION.
4. Check safety switches. Use software control to enable and activate each switch.

Two Year

1. Check the Elevator assembly for elevator drop.
2. Clean, lubricate, and adjust the microslides.

B

ELECTRICAL MEASUREMENTS

This appendix lists all the test points and electrical signals to troubleshoot the instrument. These test points are located on the Head Electronics board:

Test Point	Description
1	Transformer reference out
2	LVDC ref. signal (+3.03 V if on) before ref. error amp
3	LVDC ref signal before demodulation
4	Demodulator switch control drive
5	LVDC ref. signal after demodulator
6	Buffered reference voltage +3.03 V
7	Digital ground
8	Stepped 50 kHz sine wave
9	Ref. error amp. output
10	Force Drive +
11	Force Drive -
12	Transformer Drive -
13	Transformer Drive +
14	Buffered LVDC differential signal
15	LVDC differential signal after demodulator +
16	LVDC differential signal after demodulator -
17	LVDC differential signal in ADC +
18	LVDC differential signal in ADC -
19	LVDC differential signal after coarse gain stage
20	LVDC differential signal after fine gain stage
21	DSP operating clock
22	-8.0 V regulated supply

Test Point	Description
23	+8.0 V regulated supply
24	Auto Iris signal from camera
25	-15.0 V filtered supply
26	+12.0 V filtered supply
27	+15.0 V filtered supply
28	+5.1 VA regulated supply
29	-5.1 VA regulated supply
30	Zoom motor PWM
31	Zoom motor SIGN
32	Digital ground
33	Main lamp drive
34	Auxiliary lamp drive
35	+5 VD filtered supply
36	Drop motor PWM
37	Drop motor SIGN
38	Buffered Auto Iris
39	Auto Iris amplitude to ADC

Table B-1. *J3, Thermistor, 3-pin Mini PV*

Pin #	Name
1	Key
2	Thermistor +
3	Thermistor -

Table B-2. *J4, Force Coil/Transducer Ground, 4-pin Mini PV*

Pin #	Name	
1	Force Low	(coil wire #1)
2	Force Hot	(coil wire #2)
3	(key)	
4	LVDC ground	

Table B-3. *J5, Drop Home, 6-pin Mini PV*

Pin #	Name
1	(key)
2	Anode
3	Cathode
4	+ 5.0 Volts
5	Scan Home
6	Digital ground

Table B-4. *J6, Zoom Home, 6-pin Mini PV*

Pin #	Name
1	Anode
2	Cathode
3	+5.0 Volts
4	Elevator Home
5	Digital ground
6	(key)

Table B-5. *J7, Transformer Drive/Sense, 4-Solder Pads*

Pin #	Name	
1	Sense	Transformer wire #1
2	Sense ground	Transformer wire #2
3	Drive	Transformer wire #3
4	Drive *	Transformer wire #4

Table B-6. *J8, Debug Interface, 5-pin Mini PV*

Pin #	Name
1	Serial clock
2	Request
3	Digital ground
4	Serial output
5	Serial input

Table B-7. *J9, TV Camera Main, 8-pin Mini PV*

Pin #	Name
1	spare
2	+ 12.0 V
3	Digital ground
4	Iris ground
5	Iris signal
6	(key)
7	Video
8	Video ground

Table B-8. *J10, Proximity Detector, 5-pin Mini PV*

Pin #	Name	
1	PT +	(red)
2	PT -	(shield of red)
3	LED -	(shield of white)
4	LED +	(white)
5	(key)	

Table B-9. *J11, Lift Capacitor, 3-pin Mini PV*

Pin #	Name
1	Capacitor +
2	(key)
3	Capacitor -

Table B-10. *J12, Zoom Motor/Encoder, 8-pin Mini PV*

Pin #	Name	
1	Zoom +	(motor pin 2)
2	Zoom -	(motor pin 1)
3	spare	
4	Digital ground	
5	(key)	
6	Channel A	
7	+ 5.0 V	
8	Channel B	

Table B-11. *J13, Lamp, 5-pin Mini PV*

Pin #	Name
1	Main lamp hot
2	Lamp grid
3	Second lamp hot
4	(key)
5	Lamp ground

Table B-12. *J14, Drop Motor/Encoder, 8-pin Mini PV*

Pin #	Name	
1	Drop +	(motor pin 2)
2	Drop -	(motor pin 1)
3	(key)	
4	Digital ground	
5	spare	
6	Channel A	
7	+ 5.0 V	
8	Channel B	

Table B-13. *J15, Transformer Coax, 4-Solder Pads*

Pin #	Name
1	Wire #6 shield
2	Wire #6 center wire
3	Wire #7 center wire
4	Wire #7 shield

Table B-14. *J16, Top Transducer Plate, LEMO Coax Connector*

Connection
Connects to wire #5 from transformer

Table B-15. *J17, Bottom Transducer Plate, LEMO Coax Connector*

Connection
Connects to wire #8 from transformer

C

PC BIOS SETUP

Your Tencor profiler uses one of the following computer systems:

- A Pentium Premier II with the AT keyboard (the large keyboard)
- Pentium Advanced ZE with the PS-2 keyboard (small keyboard), a trackball (refer to this section on page 7).

To access the BIOS Setup window, do the following:

1. Turn the computer/instrument On.
2. Press the DEL key to enter the BIOS Setup window.

For clarity, the basic BIOS window is shown below (note the right side of the menu is the list of Setup window controls) as follows:

These tables show the BIOS configuration of for the Pentium Premier II computer system. Your system bios should match one of them (excluding upgrades, these are the basic system BIOS').

Table C-1. *Pentium Premier II, Main BIOS Menu*

Main Advanced Security Exit

Systems Date	05-15-1996	F1	Help
System Time	03:41:40	ESC	Back
Floppy A: Type	1.44 Mb, 3.5"	Enter	Select
Floppy B: Type	Disabled		
		↑	Previous Item
Hard Disk C:	Conner Peripherals	↓	Next Item
Hard Disk D:	Not Installed	→	Select Item
Hard Disk E:	Not Installed		
Hard Disk F:	Not Installed	F5	Set up Defaults
		F6	Previous Values
Language	English (US)	F10	Save & Exit
Boot Options	Press Enter		
Video Mode	EGA/VGA		
Mouse	Not Installed		
Base Memory	640 KB		
Extended Memory	15360 KB		

Table C-2. *Pentium Premier II, Boot Options*

Boot Options

Boot Sequence	A: First, Then C:	F1	Help
		ESC	Back
System Cache	Enabled	Enter	Select
Boot Speed	Turbo		
Num Lock	On	↑	Previous Item
		↓	Next Item
Setup Prompt	Enabled	→	Select Item
Hard Disk Pre-Delay	3 Seconds		
		F5	Set up Defaults
Typematic Rate Programming	Default	F6	Previous Values
		F10	Save & Exit

Table C-3. *Pentium Premier II, Advanced*

Main Advanced Security Exit

Processor Type	Pentium (TM) Family	F1	Help
Processor Speed	100 MHz	ESC	Back
		Enter	Select
Peripheral Configuration	Press Enter		
Advanced chipset Configuration	Press Enter	↑	Previous Item
Power Management Configuration	Press Enter	↓	Next Item
Plug and Play Configuration	Press Enter	→	Select Item
Peripheral Configuration	Press Enter		
		F5	Set up Defaults
		F6	Previous Values
		F10	Save & Exit

Table C-4. *Pentium Premier II, Peripheral Configurations*

Peripheral Configurations

Configuration Mode	Auto		
PCI IDE Interface	Enabled	F1	Help
Standard IDE Interface	Enabled	ESC	Back
Floppy Interface	Enabled	Enter	Select
Serial Port 1 Address	COM1, 3F8h	↑	Previous Item
Serial Port 2Address	COM2, 2F8h	↓	Next Item
Parallel Port Address	LPT1, 378h	→	Select Item
Parallel Port Node	Compatible		
		F5	Set up Defaults
Serial Port 1 IRQ	IRQ4	F6	Previous Values
Serial Port 2 IRQ	IRQ3	F10	Save & Exit
Parallel Port IRQ	IRQ7		

Table C-5. *Pentium Premier II, Advanced Chipset Configuration*

Advanced Chipset Configuration

Base Memory Size	640 KB	F1	Help
ISA Bus Speed	Compatible	ESC	Back
		Enter	Select
Byte Merging	Enabled		
PCI IDE Prefetch Buffers	Enabled	↑	Previous Item
		↓	Next Item
ISA LFB Size	Disabled	→	Select Item
Video Palette Snoop	Disabled	F5	Set up Defaults
Latency Timer (PCI Clocks)	66	F6	Previous Values
		F10	Save & Exit

Table C-6. *Pentium Premier II, Power Management Configuration*

Power Management Configuration

Advanced Power Management	Disabled	F1 Help ESC Back Enter Select ↑ Previous Item ↓ Next Item → Select Item F5 Set up Defaults F6 Previous Values F10 Save & Exit

Table C-7. *Pentium Premier II, Plug and Play Configuration*[a]

Plug and Play Configuration

Configuration Mode	Use Setup Utility	F1 Help ESC Back Enter Select
ISA Shared Memory Size	64 KB	
ISA Shared Memory Base Address	C0000h [b]	
		↑ Previous Item
IRQ 5	Used By ISA Card	↓ Next Item
IRQ 9	Used By ISA Card	→ Select Item
IRQ 10	Used By ISA Card	
IRQ 11	Available	F5 Set up Defaults F6 Previous Values F10 Save & Exit

a.Also refer to the next table.

b.Alternate address, shared memory required by configuration.

Table C-8. *Pentium Premier II, Plug and Play Configuration* [a]

Plug and Play Configuration

Configuration Mode	Use Setup Utility	F1 Help
		ESC Back
ISA Shared Memory Size	64 KB	Enter Select
ISA Shared Memory Base Address	C8000h [b]	
		↑ Previous Item
IRQ 5	Used By ISA Card	↓ Next Item
IRQ 9	Used By ISA Card	→ Select Item
IRQ 10	Used By ISA Card	
IRQ 11	Available	F5 Set up Defaults
		F6 Previous Values
		F10 Save & Exit

a. Also refer to the previous table.
b. Alternate address, shared memory required by configuration.

Table C-9. *Pentium Premier II, Saving Changes*

Main Advanced Security Exit

Exit Saving Changes	Press Enter	F1 Help
Exit Discarding Changes	Press Enter	ESC Back
		Enter Select
Load Setup Dafaults	Press Enter	
Discard Changes	Press Enter	↑ Previous Item
		↓ Next Item
		→ Select Item
		F5 Set up Defaults
		F6 Previous Values
		F10 Save & Exit

Table C-10. *Pentium Premier II, Security*

Main Advanced Security Exit

User Password is	Disabled	F1	Help
Administrative Password is	Disabled	ESC	Back
		Enter	Select
Set User Password	Press Enter		
Set Administrative Password	Press Enter	↑	Previous Item
		↓	Next Item
		→	Select Item
		F5	Set up Defaults
		F6	Previous Values
		F10	Save & Exit

Pentium Advanced ZE Computer

Tables C-11-C20 show one of the BIOS configurations of for the Pentium Advanced ZE computer system.

Table C-11. *Pentium Advanced ZE, Main Menu*

Main Advanced Security Exit

System Date	May 14, 1996	F1	Help
System Time	15:15:06	ESC	Back
		Enter	Select
Floppy Option	Press Enter		
		↑	Previous Item
Hard Disk C:	Conner Peripherals	↓	Next Item
Hard Disk D:	Not Installed	→	Select Item
Hard Disk E:	Not Installed		
Hard Disk F:	Not Installed	F5	Set up Defaults
		F6	Previous Values
Language	English	F10	Save & Exit
Boot Options	Press Enter		
Video Mode	EGA/VGA		
Mouse	Installed		
Base Memory	640 KB		
Extended Memory	15360 KB		

Tables C21-C30 shows the BIOS configuration for Bois Version 1.00.05.BRO.

Table C-12. *Pentium Advanced ZE, Floppy Options*

Floppy Options

Floppy A:	Installed	F1	Help
Floppy B:	Not Installed	ESC	Back
		Enter	Select
Floppy A: Type	1.44/1.25 Mb 3 1/2		
Floppy B: Type	Disabled	↑	Previous Item
Floppy Options		↓	Next Item
Floppy A:	Installed	→	Select Item
Floppy B:	Not Installed		
		F5	Set up Defaults
Floppy A: Type	1.44/1.25 Mb 3 1/2	F6	Previous Values
Floppy B: Type	Disabled	F10	Save & Exit
Floppy A:	Installed		

Table C-13. *Pentium Advanced ZE, Boot Options*

Boot Options

Boot Sequence	A: First, Then C:	F1 Help
		ESC Back
System Cache	enabled	Enter Select
Boot Speed	Turbo	
Nim Lock	On	↑ Previous Item
		↓ Next Item
Setup Prompt	Enabled	→ Select Item
Hard Disk Pre-Delay	3 Seconds	
		F5 Set up Defaults
Typematic Rate Programming	Default	F6 Previous Values
		F10 Save & Exit

Table C-14. *Pentium Advanced ZE, Advanced Options*

Main Advanced Security Exit

Processor Type	Pentium (TM) Family	F1 Help
Processor Speed	100MHz	ESC Back
Cache Size	256K	Enter Select
Peripheral Configuration	Press Enter	↑ Previous Item
Advanced Chipset Configuration	Press Enter	↓ Next Item
Power Management Configuration	Press Enter	→ Select Item
Plug and Play Configuration	Press Enter	
		F5 Set up Defaults
		F6 Previous Values
		F10 Save & Exit

Table C-15. *Pentium Advanced ZE, Peripheral Configuration*

Peripheral Configuration

Configuration Mode	Auto	F1	Help
		ESC	Back
PCI IDE Interface	Enabled	Enter	Select
Floppy Interface	Enabled		
		↑	Previous Item
Serial Port 1 Address	COM1, 3F8h	↓	Next Item
Serial Port 2 Address	COM2, 2F8h	→	Select Item
Serial Port 2 IR Mode	Disabled		
Parallel Port Address	LPT1, 378h, IRQ 7	F5	Set up Defaults
Parallel Port Mode	Compatible	F6	Previous Values
		F10	Save & Exit
Serial Port 1 IRQ	IRQ4		
Serial Port 2 IRQ	IRQ3		

Table C-16. *Pentium Advanced ZE, Advanced Chipset Configuration*

Advanced Chipset Configuration

Base Memory Size	640 KB	F1	Help
ISA LFB Size	Disabled	ESC	Back
		Enter	Select
Video Palette Snoop	Disabled		
Latency Timer (PCI Clocks)	66	↑	Previous Item
		↓	Next Item
PCI Burst	Enabled	→	Select Item
Bank 0 SIMM Detected	Fast Page Mode	F5	Set up Defaults
Band 1 SIMM Detected	Fast Page Mode	F6	Previous Values
		F10	Save & Exit

Table C-17. *Pentium Advanced ZE, Power Management Configuration*

Power Management Configuration

Advanced Power Management	Disabled	F1	Help
		ESC	Back
		Enter	Select
		↑	Previous Item
		↓	Next Item
		→	Select Item
		F5	Set up Defaults
		F6	Previous Values
		F10	Save & Exit

Table C-18. *Pentium Advanced ZE, Plug and Play Configuration*

Plug and Play Configuration

Configuration Mode	Use Setup Utility	F1	Help
		ESC	Back
ISA Shared Memory Base Address	C8000h [a]	Enter	Select
[b] IRQ 7	Used By ISA Card	↑	Previous Item
[c] IRQ 9	Used By ISA Card	↓	Next Item
IRQ 10	Used By ISA Card	→	Select Item
IRQ 11	Available		
		F5	Set up Defaults
		F6	Previous Values
		F10	Save & Exit

a. Shared memory address required for pattern recognition.
b. IRQ required by printer.
c. IRQ 9 Required for the Tencor Motion System.

Table C-19. *Pentium Advanced ZE, Security Configuration*

Main Advanced Security Exit

User Password is	Disabled	F1	Help
Administrative Password is	Disabled	ESC	Back
		Enter	Select
Set User Password	Press Enter		
Set Administrative Password	Press Enter	↑	Previous Item
		↓	Next Item
		→	Select Item
		F5	Set up Defaults
		F6	Previous Values
		F10	Save & Exit

Table C-20. *Pentium Advanced ZE, Saving Changes*

Main Advanced Security Exit

Exit Saving Changes	Press Enter	F1	Help
Exit Discarding Changes	Press Enter	ESC	Back
		Enter	Select
Load Setup Defaults	Press Enter		
Discard Changes	Press Enter	↑	Previous Item
		↓	Next Item
		→	Select Item
		F5	Set up Defaults
		F6	Previous Values
		F10	Save & Exit

PC BIOS Setup

BIOS Version 1.00.05.BR0

This version of BIOS is installed on some of the new Pentium Advanced ZE Computers w/ PS-2 Style Keyboard/Trackball. Verify that your BIOS version is 1.00.05.BRO before implementing this setup.

Table C-21. *Pentium Advanced ZE, Main BIOS Menu*

Main Advanced Security Exit

System Date:	Nov. 18, 1996	
System Time:	08:16:10	F1 Help
		ESC Back
Floppy Options	Press Enter	Enter Select
Previous Item:		Next Item
Primary IDE Master	ST3850A	Select Menu
Primary IDE Slave	Not installed	
Secondary IDE Master	Not Installed	F5 Set Up Defaults
Secondary IDE Slave:	Not Installed	F6 Previous Values
Language: English	(US)	F10 Save & Exit
Boot Options:	Press Enter	
Video Mode	EGA/VGA	
Mouse:	Installed	
Base Memory:	640 KB	
Extended memory	153360 KB	
BIOS Version	1.00.05.BRO	

Table C-22. *BIOS Version 1.00.05.BRO; Floppy Options*

		F1 Help
Floppy A:	Installed	ESC Back
Floppy B:	Not Installed	Enter Select
Floppy A:	Type 1.44/1.25Mb 31/2	Next Item
Floppy B:	Type Disabled	Select Menu
		F5 Set Up Defaults
		F6 Previous Values
		F10 Save & Exit

Table C-23. *BIOS Version 1.00.05.BRO; Boot Options*

BOOT OPTIONS

First Boot Device:	Floppy	F1 Help
Second Boot Device:	Hard Disk	ESC Back
Third Boot Device	Network	Enter Select
Fourth Boot Device:	Disabled	
		Next Item
Previous Item:		Select Menu
System Cache:	Enabled	
Boot Speed	Turbo	F5 Setup Defaults
Num Lock	On	F6 Previous Values
		F10 Save & Exit
Setup Prompt:	Enabled	
Hard Disk Pre-Delay	Disabled	
Typematic Rate Programming	Default	

Table C-24. *BIOS Version 1.00.05.BRO; Main Advanced Security Menu*

Main **ADVANCED** Security Exit

Processor Type	Pentium (R) Family	F1 Help
Processor Speed	100 Mhz	ESC Back
Cache Size	256K	Enter Select
Peripheral Configuration:	Press Enter	
Advanced Chipset Configuration:	Press Enter	
Power Management Configuration:	Press Enter	
Plug and Play Configuration:	Press Enter	F5 Setup Defaults
		F6 Previous Values
		F10 Save & Exit

Table C-25. *BIOS Version 1.00.05.BRO; Peripheral Configuration Menu*

PERIPHERAL CONFIGURATION

Configuration Mode:	Auto	F1 Help
		ESC Back
Primary PCI IDE Interface:	Enabled	Enter Select
Secondary PCI IDE Interface:	Enabled	
Floppy Interface	Enabled	Next Item
		Select Menu
Serial Port 1 Address	COM1 3F8 IRQ4	
Serial Port 2 Address	COM2 2F8 IRQ3	F5 Setup Defaults
Serial Port 2 Address	Disabled	F6 Previous Values
Parallel Port Address	LPT1 378 IRQ7	F10 Save & Exit
Parallel Port Address	Compatible	

Table C-26. *BIOS Version 1.00.05.BRO; Advanced Chipset Configuration*

ADVANCED CHIPSET CONFIGURATION		
Base Memory Size:	640 KB	F1 Help
ISA LFB Size:	Disabled	ESC Back
Video Pallete Snoop:	Disabled	Enter Select
Latency Timer (PCI Clocks)	66	Next Item
PCI Burst:	Enabled	Select Menu
Bank 0 SIMM Detected	EDO Mode	F5 Setup Defaults
Bank 1 SIMM Detected	Fast Page Mode	F6 Previous Values
		F10 Save & Exit

Table C-27. *BIOS Version 1.00.05.BRO; Power Management Configuration Menu*

POWER MANAGEMENT CONFIGURATION	
Advanced Power Management:Disabled	F1 Help
	ESC Back
	Enter Select
	Next Item
	Select Menu
	F5 Setup Defaults
	F6 Previous Values
Note: *If Advanced Power Management is Enabled, scanning a sample can cause the system to shut down.*	F10 Save & Exit

Table C-28. *BIOS Version 1.00.05.BRO; Plug and Play Configuration*

Configuration Mode		Use Setup Utility	F1 Help ESC Back
ISA Shared memory Size:		64KB	Enter Select
ISA Shared Memory Base Address:		C8000h	
Previous Item:			
	IRQ 5	Used by ISA Card	Next Item
	IRQ 9	Used by ISA Card	Select Menu
	IRQ 10	Available	
	IRQ 11	Used by ISA Card	F5 Setup Defaults
	IRQ 12	Available (Not on all units)	F6 Previous Values
NOTES:			F10 Save & Exit
Shared memory address required for Pattern Recognition IRQ 9 Required for the Tencor Motion System IRQ10 Used by Video Blaster IRQ 11 For Network card or COM4 on P-30			

Table C-29. *BIOS Version 1.00.05.BRO Main Advanced Security*

MainAdvanced **SECURITY** Exit

User Password is	Disabled	F1 Help
Administrative Password is Disabled	Disabled	ESC Back
		Enter Select
Set User Password	Press Enter	Next Item
Set Administrative Password	Press Enter	Select Menu
		F5 Setup Defaults
		F6 Previous Values
		F10 Save & Exit

Table C-30. *BIOS Version 1.00.05.BRO Main Advanced Security, Continued*

Main Advanced Security **EXIT**

		F1 Help
Exit Saving Changes:	Press Enter	ESC Back
Discarding Changes:	Press Enter	Enter Select
Load Setup Defaults	Press Enter	Next Item
Discard Changes:	Press Enter	Select Menu
		F5 Setup Defaults
		F6 Previous Values
		F10 Save & Exit

D

SPECIFICATIONS

Measurements (all models)

Roughness	R_a, Arithmetic Average Max R_a, Maximum of 19 overlapping sections R_q, Root-Mean-Square (RMS) R_p, Maximum Height R_v, Maximum Depth R_t, Maximum Peak-to-Valley R_z, Ten-Point Height R_{3z}, Six-Point Height R_h, Height between two points
Waviness	W_a, Arithmetic Average W_q, Root-Mean-Square W_p, Maximum Height W_v, Maximum Depth W_t, Maximum Peak-to-Valley W_h, Height between two points
Topography	
TIR	Total Indicator Run-out
Height	Height between two points (Step Height)
Average Height	Average height of all data points between the measurement cursors relative to the leveled baseline (Delta Averaging)
Slope	Rate of change of the profile between two points
Radius	Distance from center of curvature of profile arc to the profile
Area of Peaks	Total area bounded by the leveled baseline and the profile above the baseline
Area of Valleys	Total area bounded by the leveled baseline and the profile below the baseline

Total Area Profile Length Maximum Height	Sum of Area of Peaks and Area of Valleys Length obtained from drawing out the profile into a straight line Maximum height of trace between the measurement cursors relative to the zero line
Minimum Height	Minimum height of trace between the measurement cursors relative to the zero line
Edge	Distance to rising or falling edge or apex from start of profile
Step Width	Width of profile step
Number of Steps	Number of steps between the measurement cursors
Mean Step Height	Mean value of all the steps between the measurement cursors
Std. Dev. Step Height	Standard deviation of all the steps between the measurement cursors
Mean Peak Height	Mean value of peak heights
RMS Slope	Root-mean-square value of slopes
Average RMS Wavelegth	2π times ratio of RMS deviation of R_q to the RMS slope
Standard Deviation Heights	Standard deviation of peak heights
Bearing Length Ratio	Ratio of bearing length to sampling length at chosen value of Cutting Depth
Cutting Depth	Distance below highest peak to reference line giving chosen value of Bearing Ratio
Peak Count	Number of peak/valley pairs per unit length projecting through a band of chosen width centered about mean line
High Spot Count	Number of profile peaks per unit length projecting through a chosen reference line
Mean Peak Spacing	Mean value of the local peak spacing, where peaks are defined as in Peak Count

Table D-1. *Long-Wave Cutoff Filter Wavelengths*

mm	**in.**	**mm**	**in.**	**mm**	**in.**
0.0045	0.0002	0.14	0.006	4.5	0.18
0.008	0.0003	0.25	0.01	8.0	0.3
0.014	0.0006	0.45	0.018	14	0.55
0.025	0.001	0.8	0.03	25	1.0
0.045	0.002	1.4	0.055		
0.08	0.003	2.5	0.1		

Table D-2. *Short-Wave Cutoff Filter Wavelengths*

mm	**in.**	**mm**	**in.**	**mm**	**in.**
Default[1]		0.014	0.00056	1.4	0.056
0.00025	0.00001	0.025	0.0010	2.5	0.10
0.00045	0.00002	0.045	0.0018	4.5	0.18
0.00080	0.00003	0.08	0.0030	8.0	0.30
0.0014	0.00006	0.14	0.0056	14	0.56
0.0025	0.00010	0.25	0.010	25	1.0
0.0045	0.00018	0.45	0.018		
0.008	0.00030	0.80	0.030		

[1] Default cutoff filter values differ depending on scan speed and sampling rate. See Table D-4.

Microhead II Measurement Head

Table D-3. *MicroHead II Measurement Head (Stylus Force: 0.05–50 mg)*

Scan Method	Moving stage, stationary stylus	
	Metric	**English**
Scan Length , See Appendix E		
	Metric	**English**
Scan Speed	1 µm/sec. to 25 mm/sec.	0.04 mil/sec. to 1 in./sec.
Sampling Rate	50, 100, 200, 500, and 1000 Hz nominal	
Vertical Range:		
Microhead II Low Force		
At 0.004 Å Resolution	±3.2 µm	±0.13 mil maximum
At 0.016 Å Resolution	±13 µm	±0.5 mil maximum
At 0.08 Å Resolution	131 µm	5.2 mil maximum
Microhead xr		
At 0.008 Å Resolution	±6.5 µm	±0.26 mil maximum
At 0.08 Å Resolution	±65 µm	±2.6 mil maximum
At 0.06 Å Resolution	1000 µm	39.4 mil maximum
Microhead sr		
At 0.008 Å Resolution	±6.5 µm	±0.26 mil maximum
At 0.04 Å Resolution	±32.5 µm	±1.3 mil maximum
At 0.2 Å Resolution	327 µm	13.1 mil maximum
Vertical Linearity, below 2000Å	10Å	0.04 µin
Vertical Linearity, above 2000Å	±0.5%	±0.5%
Because the instrument linearity guarantee is significantly smaller than the uncertainty of the step height standards available in the range of typical use of the instrument, step height standards cannot be used to verify the linearity of the instrument		

Table D-3. *MicroHead II Measurement Head (Stylus Force: 0.05–50 mg) (Continued)*

Horizontal Resolution At 1 µm/sec. scan speed	0.01 µm (100Å)	0.4 µin
Stylus Control	Programmable Force: Range 0.05–50 mg Resolution 0.05 mg Full retract between scans Programmable descent rate	
Variable Sample Image Magnification Sideview optic Topview optic (include with optional dual-view optics)	 150–600 x 183–750 x and 300–1200 x (with user interchangeable lens)	

Table D-4. *Default Short-Wave Cutoff Filter Wavelengths*

Speed (µm/s)	Sampling Rate (Hz)	Short-Wave Cutoff Frequency (Hz)	Short-Wave Cutoff Wavelength (µm)
1	50	4	0.25
	100	7.5	0.13
	200	15	0.07
	500	37.5	0.03
	1000	Not Available	Not Available
2	50	4	0.5
	100	7.5	0.27
	200	15	0.13
	500	37.5	0.05
	1000	75	0.03

Table D-4. *Default Short-Wave Cutoff Filter Wavelengths (Continued)*

Speed (μm/s)	Sampling Rate (Hz)	Short-Wave Cutoff Frequency (Hz)	Short-Wave Cutoff Wavelength (μm)
5	50	4	1.3
	100	7.5	0.67
	200	15	0.33
	500	37.5	0.13
	1000	75	0.07
10	50	4	2.5
	100	7.5	1.3
	200	15	0.67
	500	37.5	0.27
	1000	75	0.13
20	50	4	5.0
	100	7.5	2.7
	200	15	1.3
	500	37.5	0.53
	1000	75	0.26
50	50	4	13
	100	7.5	6.7
	200	15	3.3
	500	37.5	1.3
	1000	75	0.67
100	50	4	25
	100	7.5	13
	200	15	6.7
	500	37.5	2.7
	1000	75	1.3

Table D-4. *Default Short-Wave Cutoff Filter Wavelengths (Continued)*

Speed (µm/s)	Sampling Rate (Hz)	Short-Wave Cutoff Frequency (Hz)	Short-Wave Cutoff Wavelength (µm)
200	50	4	50
	100	7.5	27
	200	15	13
	500	37.5	5.3
	1000	75	2.6
400	50	4	100
	100	7.5	53
	200	15	27
	500	37.5	11
	1000	75	5.3
1000	50	4	250
	100	7.5	130
	200	15	67
	500	37.5	27
	1000	75	13

Stylus Applied Force MicroHead *sr*: 1.0–50 mg

Sample Handling (all models)

Wafer Sizes	100 mm, 125 mm, 150 mm, and 200 mm	
X-Y	Unlimited programmable locations	
Manual Control	Use trackball or keyboard	
	Metric	**English**
Maximum Sample Size	**See Appendix E**	
(Standard Configuration)	Note: 355 x 355 mm (14 x 14 in.) with side panel removed.Stylus can access any part of a 205150-mm (8.16-in.) round sample without sample repositioning.	
(P-11 Only) Maximum Sample Size (Open Frame Configuration)	430 x 430 mm	17 x 17 in.
	Note: 480 x 480 mm (19 x 19 in) with side panel removed.	
Maximum Sample Weight	2.2 kg.	5 lb.
Throat Depth	228 mm	9 in.
Throat Height, incl. Rotary Stage	63.5 mm	2.12 in.
X,Y Maximum Travel	**See Appendix E**	
X,Y Positioning Speed	Variable up to 25 mm/sec.	1 in./sec.
Motorized Stage Rotation		
Angle Resolution	0.001^{o}	
Leveling	Electronic leveling of traces is standard. Automatic mechanical leveling of sample with Motorized Level and Rotation Option.	
Vacuum Hold-Down of Sample	Standard	
Custom Fixturing Interface	Three 8-32 UNC 2B threaded holes on 3.16-in. diameter circle, 90^{o} apart	

Measurement Control

Manual/Single Scan Mode	Continuous or segmented scan, from recipe
Repeat and Average Mode	Scan repeated up to ten times and averaged

Data Storage

Hard Disk	835 MB or greater. Stores over 20,000 scans at 1000 points each.
Diskette	1.44 MB, 3.5 in. Data storage limited to approximately 100 recipes and 200 scans at 1000 points each. (300 scans per diskette dedicated to data.)
Storage Requirements	DOS Operating System: approx. 6 KB
(estimates only)	Microsoft Windows program: approx. 10 MB
	Tencor Profiler program: approx. 11 KB
	Recipe: 215 bytes
	Single-scan data: 652 bytes plus trace data
	Trace data: Trace data storage requirements are added to that for the scan data
	2D trace data: minimum 2K bytes for the first 505 data points plus 4 times the number of data points thereafter
	3D trace data: 2122 bytes minimum plus 2048-byte increments
	32 bytes per trace (range 1 to 210 inclusive)
	4 bytes per data point
	Approximate number of data points = number of traces × scan length × sampling rate/scan speed

Data Analysis

Interactive Graph	Two-cursor read-out. Cursors move independently or in tandem.
Measurement or Leveling	Each cursor is expandable into a region for measurement.
Zoom Box Data Expansion	Portion of a graph can be magnified.
Data Catalog	Immediate data retrieval and display from catalog
Metric Units	Parameters displayed in preprogrammed metric or English units; independent selection of horizontal and vertical parameters.

Equipment Specifications

Processor	Pentium 100-MHz microprocessor (subject to change). Runs MS-DOS version 6.22.
RAM	16 MB
Monitor	15 in. SVGA Displays magnified image of the sample or output data. Initial data trace or cross-hair identification of stylus location relative to stage can be superimposed on sample image.
	High resolution
	Color data display, user-selectable colors
Standard Keyboard	Enhanced 101 AT with trackball
Real-Time Clock	Battery-backed clock provides date and time of day.

THE PROFILER PRODUCTS SPECIFICATIONS

Table E-1. *Profiler Options*

Model	P-10	P-11	P-12	P-22	P-30
Scan Method	moving stage	moving stage	moving stage	moving stage	moving stage
Scan Length Max.	60 mm	205 mm	150 mm	205 mm	20T
Sample Size Max.	254 mm	200 mm	130 mm	200 mm	200
Handler	no	no	no	yes	yes
Stage Motion	150X150 mm	210 mm circle	150X150 mm	210 mm circle	20 mm
Theta	360	360	360	360	360
Leveling - Stage	optional	optional	motorized	motorized	motorized
Scan Head	MHII MHII*sr* MHII*xr*	MHII MHII*sr* MHII*xr*	MHII	MHII*xr* MHII	MHII MHII*sr* MHII*xr*
Software Platform	DOS/Windows	Windows	DOS/Windows	Windows	Windows
Pattern Recognition	no	optional	no	optional	standard
Sequencing	no	standard	standard	standard	standard
Dimensions:					
Width:	57cm (23 in.)	Same as P10	76cm (30 in.)	134cm (53 in.)	114cm (45 in.)
Height:	w/o monitor 46cm (17.5 in.) w/monitor 84cm (34 in.)	Same as P10	168cm (66 in.)	169cm (66 in.)	152cm (60 in.)

Model	**P-10**	**P-11**	**P-12**	**P-22**	**P-30**
Depth:	(w/o key-board) 78 cm (31 in.) (w/keyboard) 103 cm(41 in.)	Same as P10	109cm (43 in.)	77cm (30 in.)	114cm (45 in.)
Weight, Instrument:	100kg (219 lbs)	Same as P10	100kg (219lbs)	397 kg (875lbs.)	272 kg (600 lbs)
Weight, Shipping:	163kg (360 lbs)	Same as P10	163kg (360 lbs)	681 kb (1500 lbs)	363 kg (800 lbs)
Vibration Isolation Table weight:	N/A	N/A	168 kg (370 lbs)	N/A	N/A
Weight, Shipping:	N/A	N/A	232 kg (510lbs)	N/A	N/A

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