

APPENDIX A SPECIFICATIONS

MEASUREMENTS

Roughness	<p>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</p>
Waviness	<p>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</p>
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	Sum of Area of Peaks and Area of Valleys
Profile Length	Length obtained from drawing out the profile into a straight line
Maximum Height	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 Wavelength	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 A-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 A-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 A-3.

Table A-3 Default Short Wave Cutoff Filter Wavelengths

Speed ($\mu\text{m/s}$)	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
5	50	4	1.3
	100	7.5	0.67
	200	15	0.33
	500	37.5	0.13
	1000	75	0.07

Table A-3 Default Short Wave Cutoff Filter Wavelengths (continued)

Speed (µm/s)	Sampling Rate (Hz)	Short Wave Cutoff Frequency (Hz)	Short Wave Cutoff Wavelength (µm)
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
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

MICROHEAD MEASUREMENT HEAD

Scan Method	Moving stage, stationary stylus	
Stylus Applied Force	MicroHead <i>sr</i> : 1.0–50 mg MicroHead <i>xr</i> : 0.5–50 mg Low Force MicroHead II: 0.05–50 mg	
	Metric	English
Scan Length	60 mm	2.3 in. maximum
Scan Speed	1 $\mu\text{m}/\text{sec.}$ to 25 mm/sec.	0.04 mil/sec. to 1 in./sec.
Sampling Rate	50, 100, 200, 500, and 1000 /sec nominal	
Vertical Range ¹		
MicroHead <i>sr</i>		
At 0.008 \AA Resolution	$\pm 6.5 \mu\text{m}$	$\pm 0.26 \text{ mil maximum}$
At 0.04 \AA Resolution	$\pm 32.5 \mu\text{m}$	$\pm 1.28 \text{ mil maximum}$
At 0.2 \AA Resolution	327 μm	12.8 mil maximum
MicroHead <i>xr</i>		
At 0.008 \AA Resolution	$\pm 6.5 \mu\text{m}$	$\pm 0.26 \text{ mil maximum}$
At 0.08 \AA Resolution	$\pm 65 \mu\text{m}$	$\pm 2.56 \text{ mil maximum}$
At 0.6 \AA Resolution	1000 μm	39.4 mil maximum
Low Force MicroHead II		
At 0.004 \AA (0.004 $\mu\text{in.}$) Resolution	$\pm 3.2 \mu\text{m}$	$\pm 0.13 \text{ mil maximum}$
At 0.016 \AA (0.008 $\mu\text{in.}$) Resolution	$\pm 13 \mu\text{m}$	$\pm 0.51 \text{ mil maximum}$
At 0.08 \AA (0.04 $\mu\text{in.}$) Resolution	131 μm	5.2 mil maximum
Vertical Linearity, below 2000 \AA	10 \AA	0.04 μin
Vertical Linearity, above 2000 \AA	$\pm 0.5\%$	$\pm 0.5\%$

NOTE: 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.*

	Metric	English
Horizontal Resolution		
At 1 $\mu\text{m}/\text{sec.}$ scan speed	0.01 μm (100 \AA)	0.4 μin

¹ The vertical resolutions listed here represent the smallest discrete measurable units for each vertical range. Actual measurements will reflect somewhat higher resolutions due to the effects of noise and surface scan characteristics.

Stylus Control	Programmable Force
	Range 1.0–50 mg (MicroHead <i>sr</i>) 0.5–50 mg (MicroHead <i>xr</i>) 0.05–50 mg (Low Force MicroHead II)
	Resolution 0.01 mg
	Full retract between scans Programmable descent rate
Variable Sample Image Magnification	MicroHead <i>sr</i> : top or side-view optics 90°: 115–465x and 185–750x 45°: 95–410x
	MicroHead <i>xr</i> : dual-view optics 90°: 115–465x and 185–750x 45°: 95–410x
	MicroHead <i>xr</i> : dual-view optics 90°: 115–465x and 185–750x 45°: 95–410x

SAMPLE HANDLING

X-Y Manual Control	Unlimited programmable locations Via trackball or keyboard	
Maximum Sample Size (Standard Configuration)	Metric 254 x 254 mm Note: 355 x 355 mm (14 x 14 in.) with side panel removed Stylus can access any part of a 150-mm (8.2-in.) round sample without sample repositioning.	English 10 x 10 in.
	Maximum Sample Size (Open Frame Configuration)	430 x 430 mm 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	2.5 in.
X,Y Maximum Travel	150 mm	6 in.
X,Y Positioning Speed	Variable up to 25 mm/sec.	1 in./sec.
Motorized Stage Rotation		
Angle Resolution	0.001°	
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° apart.	

MEASUREMENT CONTROL

Manual/Single Scan Mode
Repeat and Average Mode

Continuous or segmented scan, from recipe
Scan repeated up to ten times and averaged

DATA STORAGE

Hard Disk
Diskette

850 MB. Stores over 20,000 scans at 1000 points each.
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

The following figures are estimates only.

DOS Operating System: approx. 6 KB

Microsoft Windows program: approx. 10 MB

Tencor P-11 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 in-
crements

32 bytes per trace (range 1 to 210 inclusive)

4 bytes per data point

Approximate number of data points = number of traces \times
scan length \times sampling rate/scan speed

DATA ANALYSIS

Interactive Graph

Two cursor read-out. Cursors move independently or in
tandem.

Delta Averaging
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/English Units

Parameters displayed in preprogrammed metric or En-
glish units; independent selection of horizontal and ver-
tical 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
Vibration Isolation Table	A custom instrument table
Real-Time Clock	Battery-backed clock provides date and time of day

PHYSICAL SPECIFICATIONS

	Metric	English
Dimensions, standard configuration		
Width	57 cm	23 in.
Height	46 cm	17.5 in.
Depth	84 cm	34 in.
Dimensions, Open Frame configuration, with isolation hood in place		
Width	74 cm	29 in.
Height	46 cm	17.5 in.
Depth	90 cm	35 in.
Weight		
Instrument	68 kg	150 lb.
Shipping Weight	127 kg	280 lb.
Electrical	90-110 V, 50/60 Hz 110-130 V, 50/60 Hz 180-260 V, 50/60 Hz	
Power requirements	150 VA	