

## Application Note 2

# Leveling with the L-730 and L-740 Laser Systems

### L-730/L-740 Applications

- General Leveling • Sole Plate Flatness
- Machine Bed Flatness and Straightness
- Surface Plate Flatness • Large Part Flatness
- Wind Tower Flange Flatness

## How the Alignment System Works

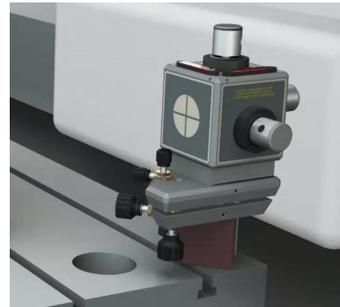
There are two ways of checking flatness on a surface:

- **Levels** - Using our built-in level vials and using Earth-Level as a reference.
- **3 Reference Points** - Using 3 reference points and aligning the laser to those points, which we call “bucking-in”.

The L-730/L-740 laser can do either method with ease.

### Checking Flatness using Level Vials

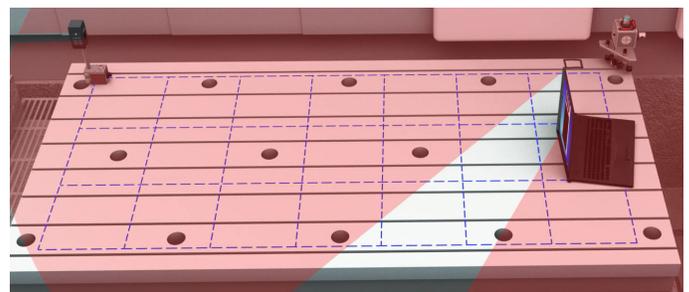
1. To check flatness using the level vials, put the laser on an instrument stand or stable mounting surface and level in two axes.



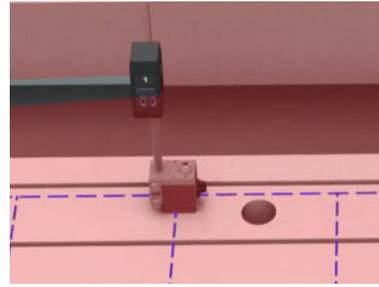
2. Place an A-1519-2.4ZB/A-1520-2.4ZB target on one reference point, mark an outline around the magnetic base, and electronically zero the target by tapping the **Zero** button in the Read9 Software on the PDA.



3. The laser is now ready to measure the surface for levelness/flatness.



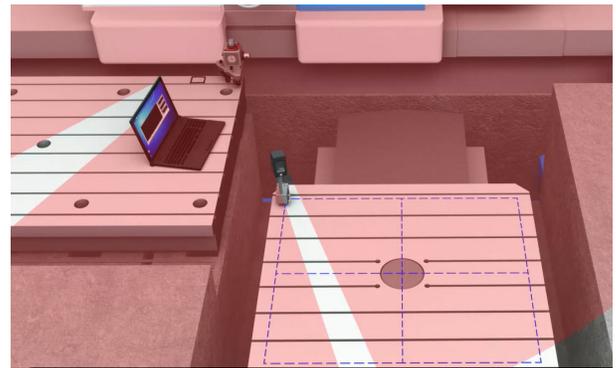
4. Move the target to a measurement point on the surface, where it displays the deviation of that point from the reference point. If the display shows a “+,” the measurement point is higher than the reference point. If it displays a “-,” the point is low relative to the reference point.



5. You can leave a target on the measurement point and if you need to level it, you can watch the data update live while you adjust the machine. When it reads zero, you’re done!



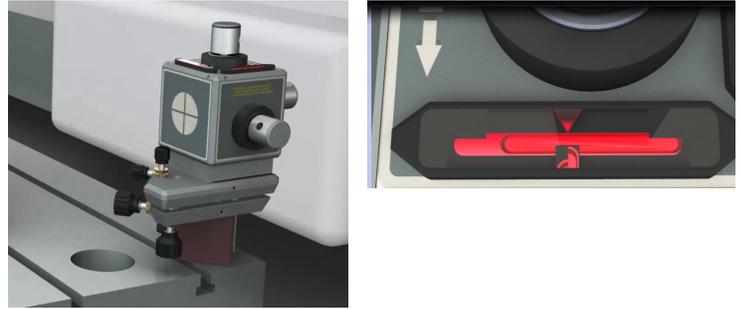
6. You can also check parallelism of a separate surface by moving the target to that surface. The difference from the zero point on the first surface is a measure of the elevation difference from the first surface to the second. For example, say you leveled the laser and zeroed the target on a point on surface #1. Then you moved it to the closest corner on surface #2 and you get -.015". This means that corner of surface #2 is lower by .015" relative to the first surface. Then if you move the target to another corner and get -.020", then this means surface #2 is not only *lower* by .015", but it is also not parallel (along 1 of the 2 axes) by .005".
7. Please note that if a machine bed is going to be *aligned* (leveled) rather than just measured, it is important to place the laser on an instrument stand. If the laser is on the same machine bed or table that needs to be aligned, adjusting it will most likely move the laser and affect the setup.



### Checking Flatness with the 3-Point Buck-in Method (make parallel to)

Sometimes surfaces are flat but not level, so using *level* as a reference to check flatness may add unnecessary time and make a perfectly flat surface look like it’s out of specification. To solve this problem, we recommend using three points on a surface as the references, which provides a very accurate way to check surface flatness and eliminates errors caused by surfaces not being level. It also allows the use of reference targets to monitor laser drift, which is very important on large machine beds and parts. This is because small tilts in the surface the laser is mounted on become big movements in the laser when distances are greater than 15' feet (4.5 M).

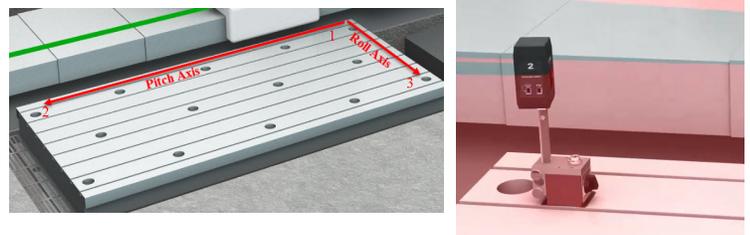
1. Place the laser on an instrument stand or stable mounting surface and level in two axes. This makes the laser fairly close to being parallel to the surface.



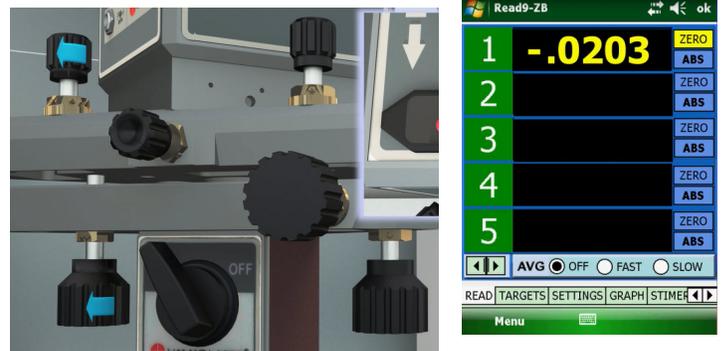
2. Place an A-1519-2.4ZB/A-1520-2.4ZB target on one reference point (#1) right next to the laser, mark an outline around the magnetic base and electronically zero the target by tapping the **Zero** button in the Read9 Software on the PDA.



3. Move the target to the farther point (#2) along the Pitch Axis and mark the outline of the magnetic base.

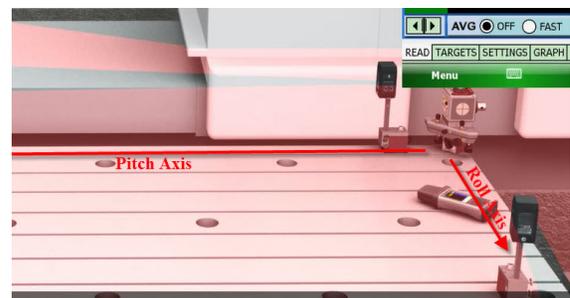


4. Turn the Pitch Axis coarse and fine adjustment knobs until the PDA reads zero.

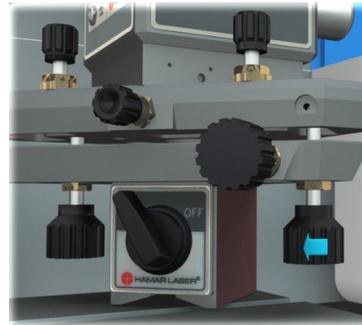


5. Move the Target back to Point #1 and re-zero. Repeat Steps 4 and 5 until you get zero at both Point #1 and Point #2.

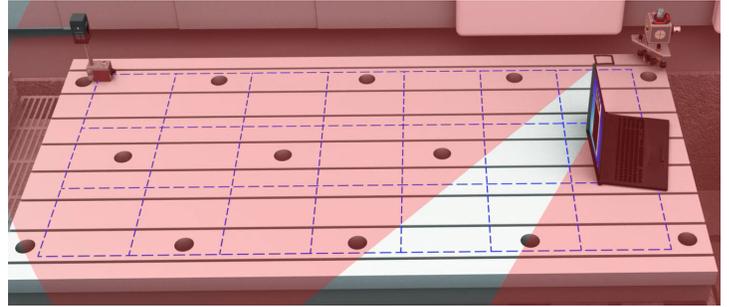
6. Now move the target to the farthest point (#3) away from the laser on the Roll Axis.



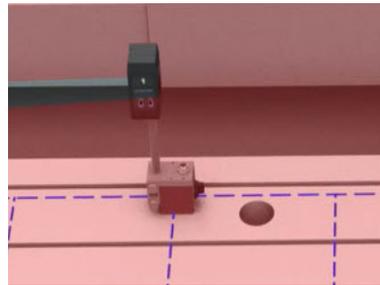
- Turn the Roll Axis coarse and fine adjustment knobs until the PDA reads zero.



- Return the target to Point #1 to verify that it reads zero, then move it to Point #2 to verify that it reads zero. If so, the laser is now bucked-in (aligned) to 3 points on the surface and you're ready to take data.



- Move the target to a measurement point on the surface where it displays the deviation of that point from the reference point. If the display shows a "+," the measurement point is higher than the 3 reference points. If it displays a "-," the point is low relative to the reference points.

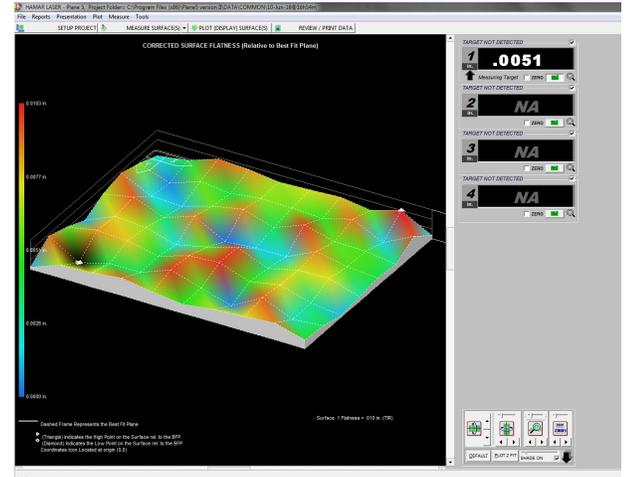


- As discussed above, you can leave the target over an adjustment point and watch it update in real time. You can also measure parallelism as described above.

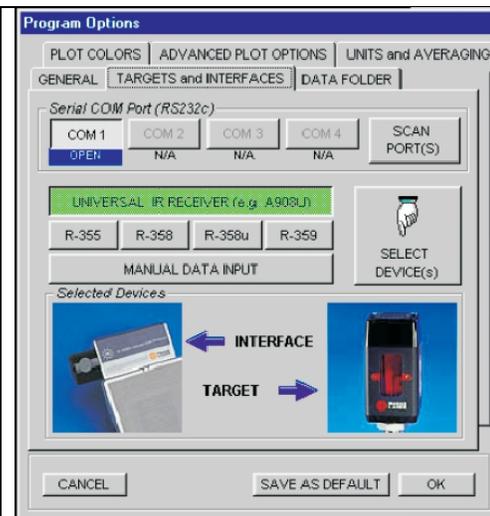
## Using Plane5 Flatness Software

Instead of using our R-1355-2.4ZB PDA display, our Plane5 Software can be used with the L-730/L-740 to quickly download flatness data for analysis and reporting. Plane5 employs a least-squares, best-fit algorithm to eliminate slope errors in the data from the laser not being parallel to the surface. This can save time on the buck-in process.

Plane5 can plot the flatness for squares, rectangles, flanges, circles, surface plate Moody Method and also plot out parallel surfaces. It displays up to 5 targets at the same time and produces a color report that can be emailed.

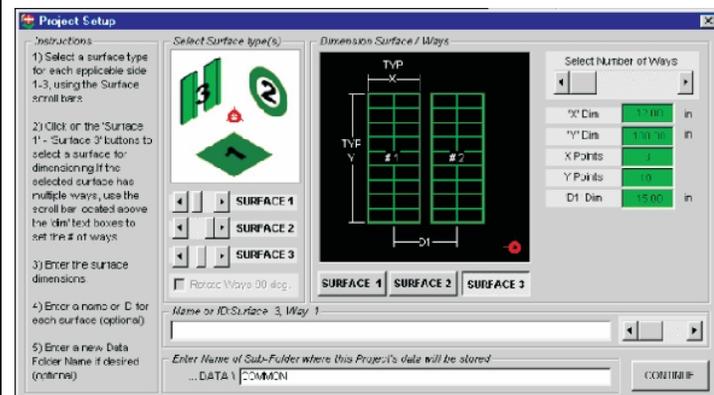


## Plane5 Features



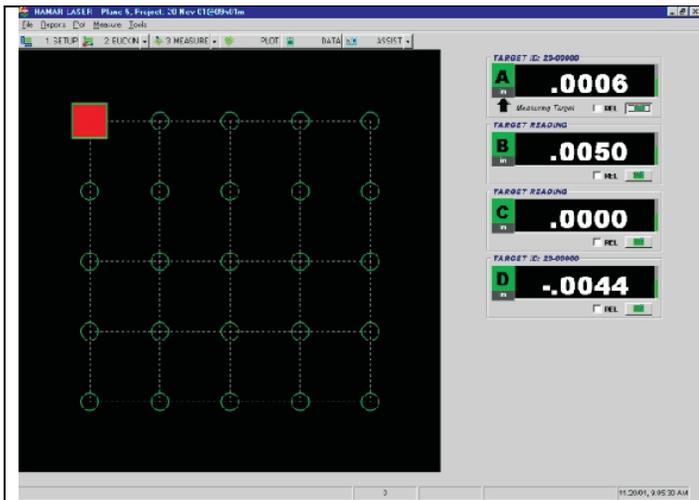
### SELECTING PROGRAM OPTIONS

When Plane5 loads, it searches the available COM ports for the target type and communication device connected to the computer and automatically selects the detected items when the **Program Options** screen displays. The **Program Options** screen also allows the user to set up parameters such as measuring units, the number of averages taken to minimize the effects of air turbulence and vibration on the readings, and plotting options.



### DEFINING A PROJECT

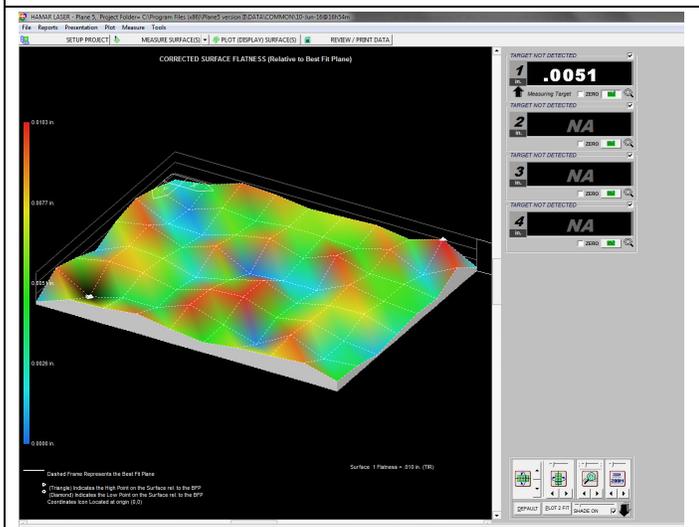
The **Project Setup** screen allows the user to define a new project. Up to 3 surfaces, 1 horizontal and 2 vertical, and their shapes (square, rectangle, frame, circle, ring or up to 5 ways) can be selected. The X, Y dimensions of each surface and the number of points to be measured are entered. The laser setup wizard can then be used to aid in making the laser plane parallel to reference points.



## TAKING DATA

The **Data Taking** screen displays a grid of one of the surfaces to be measured. Using the mouse, the cursor is moved to the first data point and the space bar is pressed to record the measurement. The software marks the recorded point with a circle and automatically moves to the next point. When the cursor is placed on a point already measured, the software displays the X, Y coordinate and the measurement. Data can be retaken for any point if necessary.

1. Place the laser on the surface and roughly level, making the laser plane approximately parallel to the surface.
2. Set up the target on one point and zero. The grid pattern is then laid out in Plane5 and on the surface itself. For repeatability, it is important to mark the data points on the surface.
3. Move the target along the surface and press the spacebar to record each data point. Once all the points have been taken, the software automatically calculates the flatness data and it can be reviewed in the report section of the software.

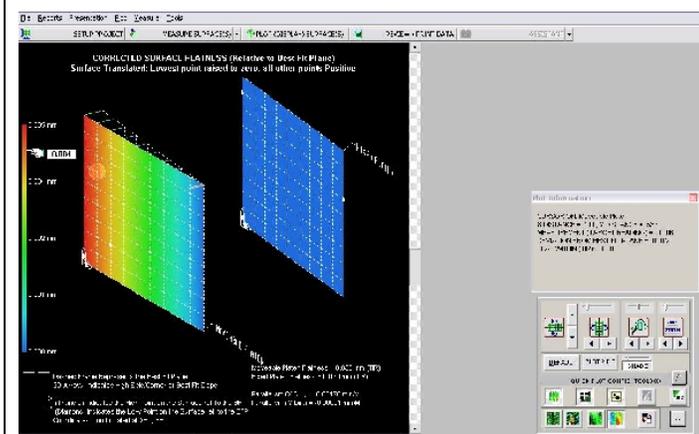


## PLOTTING DATA

The **Data Plotting** screen graphically displays a 3-dimensional plot of surface flatness. Up to 3 surface plots (1 horizontal and 2 vertical) can be displayed on the graph. For each surface, the data is plotted and the least-squares best-fit plane is drawn.

The graph can also display high and low points, grid lines and the slope high point of the best-fit plane. A display box shows the X, Y coordinates and the measurement point where the cursor passes over each point on the graph. The TIR and the high and low points are also shown for each surface. The user can rotate each graph and zoom in on certain sections for detailed analysis.

Another plotting option is a parallel surface plot, depicting the parallelism of either vertical or horizontal surfaces and providing the results in either in./ft. or mm/M. This plot compares the slopes of the least-squares best-fit planes for both sets of data, providing the parallelism. Plane5 can also calculate the squareness between the LSBF planes of vertical surfaces to horizontal surfaces.



# GENERATING REPORTS

Create and save a report from any recorded data. The user can select a variety of configuration options, including graphics of the plot and data tables for single or multiple surfaces. If multiple surfaces are measured, a comparison of the surfaces is provided.

## HAMAR LASER - Plane 5 Report

Page 1

### Alignment Summary

Company Name: Acme Corporation  
 Address: 5 Main St.  
 City: Davenport  
 State/Province/Zip: IA  
 User Name: Bob  
 Comments: Looking good!

Country: USA  
 Station / Location: Plane 2

### Flatness

Surface 1 ..... 0.007 in (TR)  
 Surface 2, Way 1 ..... 0.030 in (TR)  
 Surface 2, Way 2 ..... 0.087 in (TR)  
 Surface 3 ..... 0.091 in (TR)

### Slope of Best Fit Plane relative to Laser Plane

Surface 1 (X Slope) ..... 0.00984 in/Ft, 17.1 arc secs.  
 Surface 1 (Y Slope) ..... 0.00784 in/Ft, 15.0 arc secs.  
 Surface 2, Way 1 (X Slope) ..... 0.01197 in/Ft, 13.8 arc secs.  
 Surface 2, Way 1 (Y Slope) ..... 0.01070 in/Ft, 13.5 arc secs.  
 Surface 2, Way 2 (X Slope) ..... 0.01084 in/Ft, 13.2 arc secs.  
 Surface 2, Way 2 (Y Slope) ..... 0.01084 in/Ft, 13.2 arc secs.  
 Surface 3 (X Slope) ..... 0.01113 in/Ft, 13.1 arc secs.  
 Surface 3 (Y Slope) ..... 0.00705 in/Ft, 12.1 arc secs.

NOTE: Slope is positive when the surface rises away from the origin

### Squareness (Perpendicularity)

'Surface 1' TO 'Surface 2, Way 1' ..... -0.00318 in/Ft, -5.5 arc secs, Learning Away from each other  
 'Surface 1' TO 'Surface 2, Way 2' ..... -0.00289 in/Ft, -5.0 arc secs, Learning Away from each other  
 'Surface 1' TO 'Surface 3' ..... 0.00288 in/Ft, 5.0 arc secs, Learning Towards each other  
 'Surface 2, Way 1' TO 'Surface 2' ..... -0.01095 in/Ft, -17.2 arc secs, Learning Away from each other  
 'Surface 2, Way 2' TO 'Surface 3' ..... -0.01187 in/Ft, -20.4 arc secs, Learning Away from each other

### Ways/Columns Parallelism

Surface 2, Way 1 TO Surface 2, Way 2 (X Dir.) ..... 0.00181 in/Ft, 3.1 arc secs.  
 Surface 2, Way 1 TO Surface 2, Way 2 (Y Dir.) ..... -0.00050 in/Ft, -0.8 arc secs.

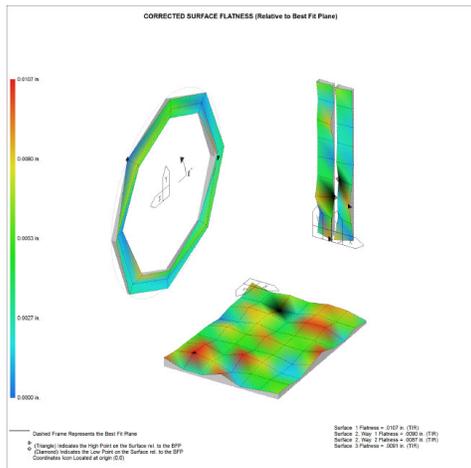
## HAMAR LASER - Plane 5 Report

Page 2

### Surface Plot

Company Name: Acme Corporation  
 Address: 5 Main St.  
 City: Davenport  
 State/Province/Zip: IA  
 User Name: Bob  
 Comments: Looking good!

Country: USA  
 Station / Location: Plane 2



## HAMAR LASER - Plane 5 Report

Page 3

### Surface 1 (Surface 1)

X Distance	Y Distance	Raw Flatness Data	Corrected Flatness*	Comments
0	0	-0.010	-0.001	
0	10.0	-0.005	-0.002	
0	20.0	-0.001	-0.002	
0	30.0	-0.004	-0.002	
0	40.0	-0.007	-0.001	
0	50.0	-0.004	-0.001	
0	60.0	-0.001	-0.002	
0	70.0	-0.001	-0.001	
0	80.0	-0.002	-0.004	
10.0	0	-0.004	-0.016	
10.0	10.0	-0.004	-0.017	
10.0	20.0	-0.004	-0.004	
10.0	30.0	-0.004	-0.004	
10.0	40.0	-0.004	-0.004	
10.0	50.0	-0.004	-0.010	
10.0	60.0	-0.004	-0.014	
10.0	70.0	-0.004	-0.011	
10.0	80.0	-0.004	-0.008	
20.0	0	-0.001	-0.001	
20.0	10.0	-0.004	-0.002	
20.0	20.0	-0.001	-0.019	
20.0	30.0	-0.001	-0.001	
20.0	40.0	-0.001	-0.004	
20.0	50.0	-0.001	-0.001	
20.0	60.0	-0.001	-0.019	
20.0	70.0	-0.001	-0.007	
20.0	80.0	-0.002	-0.006	
30.0	0	-0.002	-0.006	
30.0	10.0	-0.004	-0.006	
30.0	20.0	-0.001	-0.019	
30.0	30.0	-0.001	-0.013	
30.0	40.0	-0.001	-0.010	
30.0	50.0	-0.001	-0.010	
30.0	60.0	-0.001	-0.014	
30.0	70.0	-0.001	-0.014	
30.0	80.0	-0.001	-0.014	
40.0	0	-0.001	-0.008	
40.0	10.0	-0.001	-0.008	
40.0	20.0	-0.001	-0.014	
40.0	30.0	-0.001	-0.001	
40.0	40.0	-0.001	-0.005	
40.0	50.0	-0.001	-0.005	
40.0	60.0	-0.001	-0.005	
40.0	70.0	-0.001	-0.002	
40.0	80.0	-0.001	-0.002	
50.0	0	-0.001	-0.009	
50.0	10.0	-0.001	-0.005	
50.0	20.0	-0.001	-0.009	
50.0	30.0	-0.001	-0.009	
50.0	40.0	-0.001	-0.003	
50.0	50.0	-0.001	-0.003	
50.0	60.0	-0.001	-0.003	
50.0	70.0	-0.001	-0.016	
50.0	80.0	-0.001	-0.008	
60.0	0	-0.001	-0.005	
60.0	10.0	-0.001	-0.005	
60.0	20.0	-0.001	-0.005	

Note:  
 \*Corrected Flatness = Surface Deviation (Z) from the Best Fit Plane at each X,Y location  
 Raw Flatness Data = Z only measurements, as recorded  
 Surface Data Shifted by: Low Point=0, all other points Positive