Application Note

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

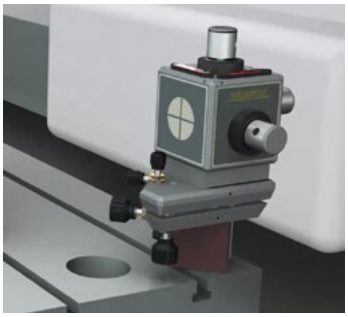
There are two ways of checking flatness on a surface:

- **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.

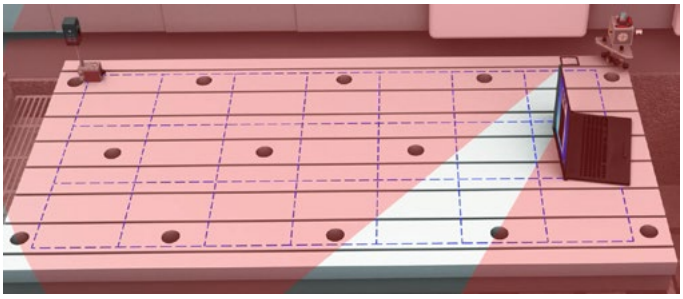
Checking Flatness using Level Vials

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.



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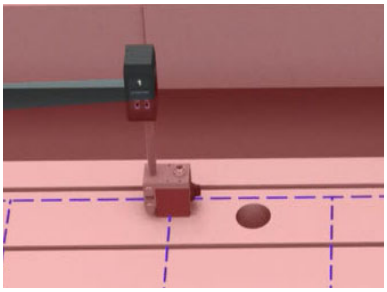
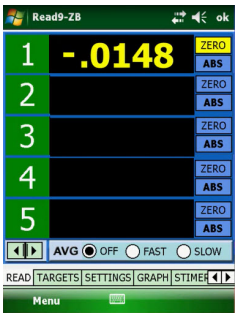
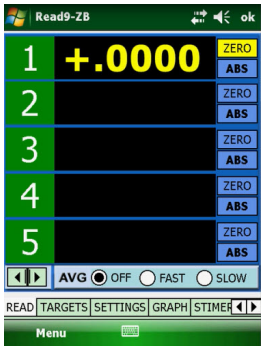
4. Move the target to a measurement point on the surface, where it displays the deviation of that point from the reference point. If the display shows a "+," the measurement point is higher than the reference point. If it displays a "-," the point is low relative to the reference point.

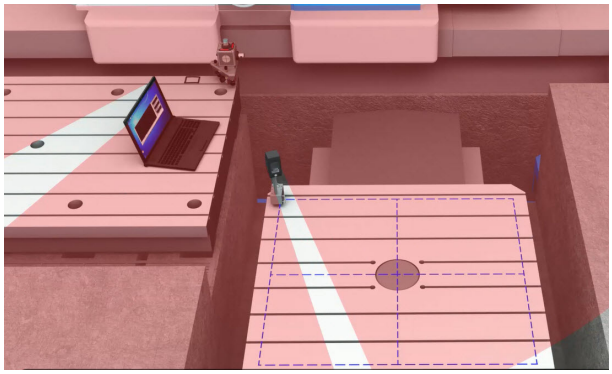




5. You can leave a target on the measurement point and if you need to level it, you can watch the data update live while you adjust the machine. When it reads zero, you're done!



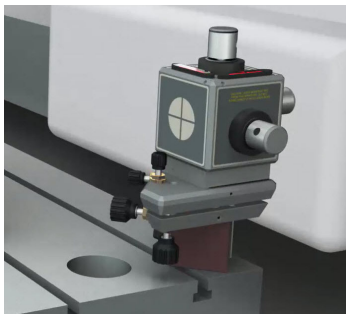
6. You can also check parallelism of a separate surface by moving the target to that surface. The difference from the zero point on the first surface is a measure of the elevation difference from the first surface to the second. For example, say you leveled the laser and zeroed the target on a point 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.



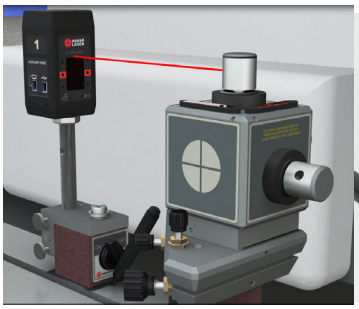
Checking Flatness with the 3-Point Buck-in Method (make parallel to)

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).

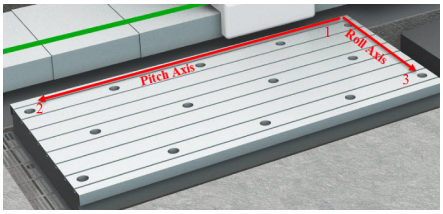
1. Place the laser on an instrument stand or stable mounting surface and level in two axes. This makes the laser fairly close to being parallel to the surface.

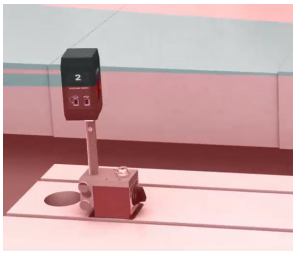


2. Place an A-1519-2.4ZB/A-1520-2.4ZB target on one reference point (#1) right next to the laser, mark an outline around the magnetic base and electronically zero the target by tapping the **Zero** button in the Read9 Software on the PDA.

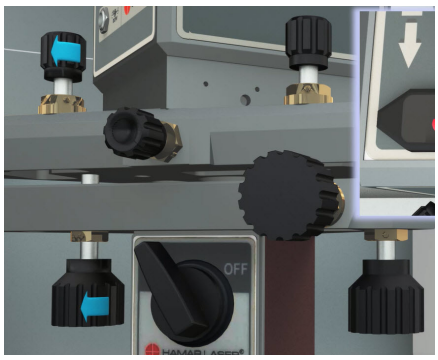


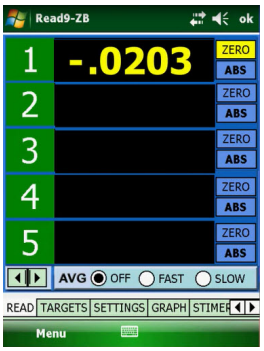
3. Move the target to the farther point (#2) along the Pitch Axis and mark the outline of the magnetic base.





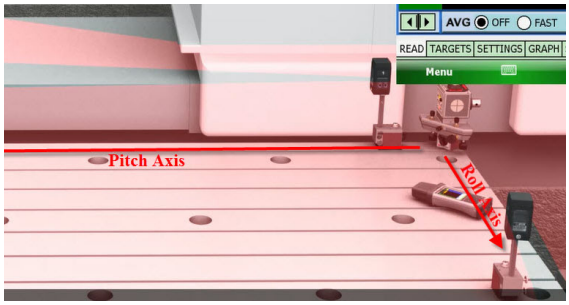
4. Turn the Pitch Axis coarse and fine adjustment knobs until the PDA reads zero.



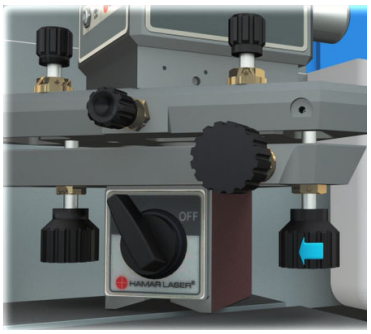


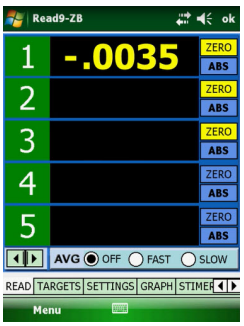
5. Move the Target back to Point #1 and re-zero. Repeat Steps 4 and 5 until you get zero at both Point #1 and Point #2.

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

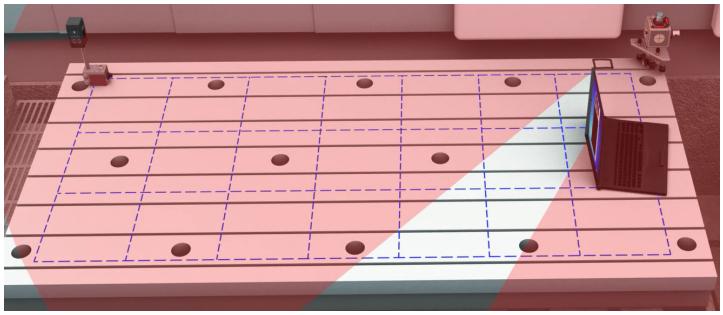


7. Turn the Roll Axis coarse and fine adjustment knobs until the PDA reads zero.

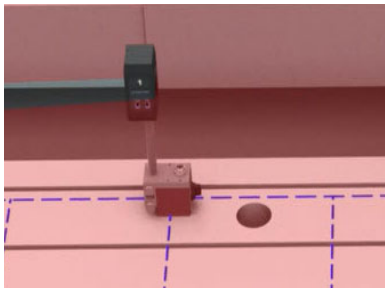




8. Return the target to Point #1 to verify that it reads zero, then move it to Point #2 to verify that it reads zero. If so, the laser is now bucked-in (aligned) to 3 points on the surface and you're ready to take data.



9. 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.

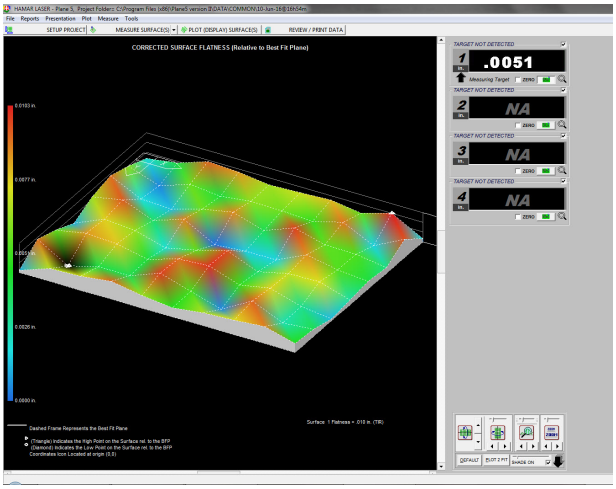


10. As discussed above, you can leave the target over an adjustment point and watch it update in real time. You can also measure parallelism as described above.

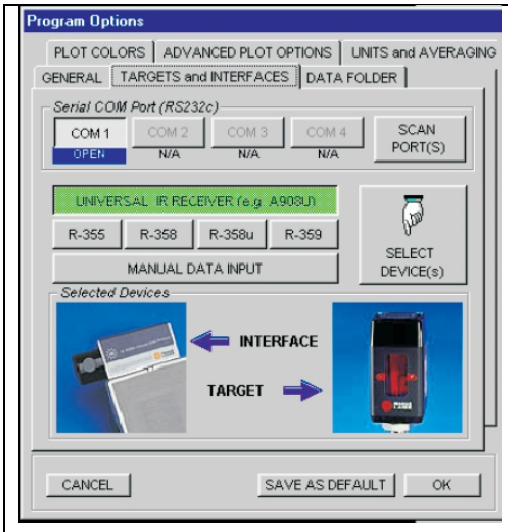
Using Plane5 Flatness Software

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.

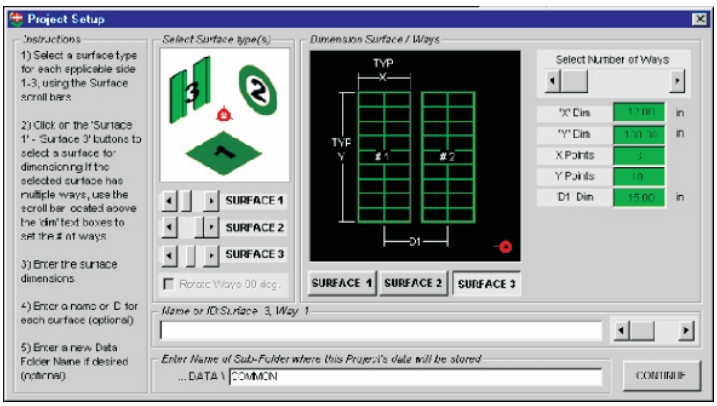


Plane5 Features



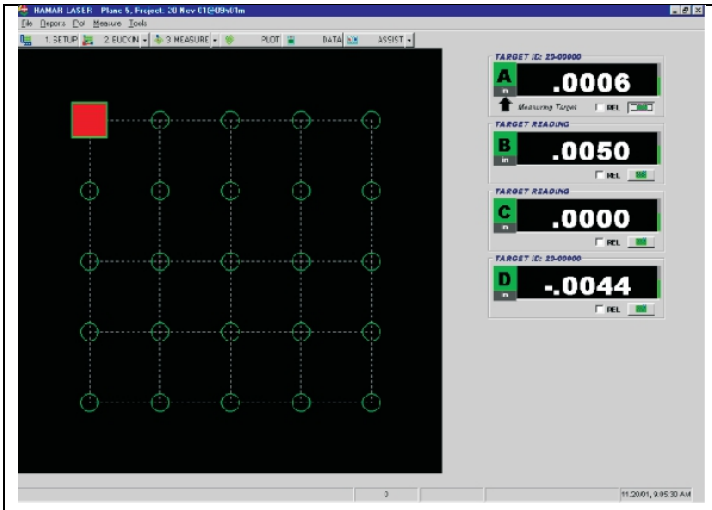
SELECTING PROGRAM OPTIONS

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

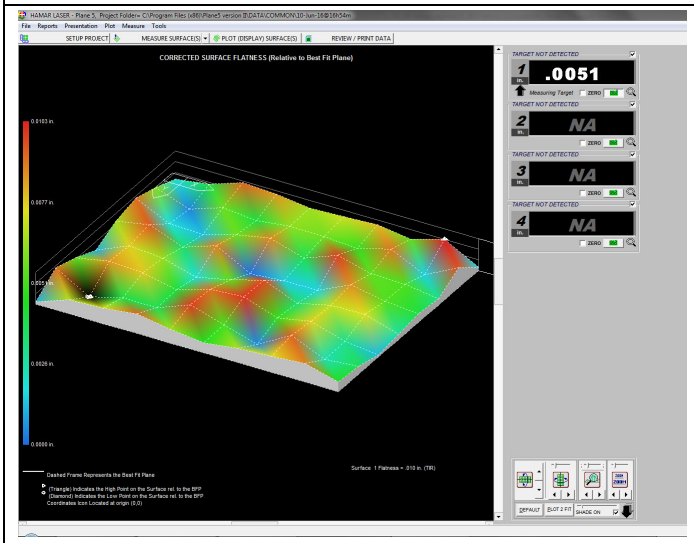
The **Project Setup** screen allows the user to define a new project. Up to 3 surfaces, 1 horizontal and 2 vertical, and their shapes (square, rectangle, frame, circle, ring or up to 5 ways) can be selected. The X, Y dimensions of each surface and the number of points to be measured are entered. The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

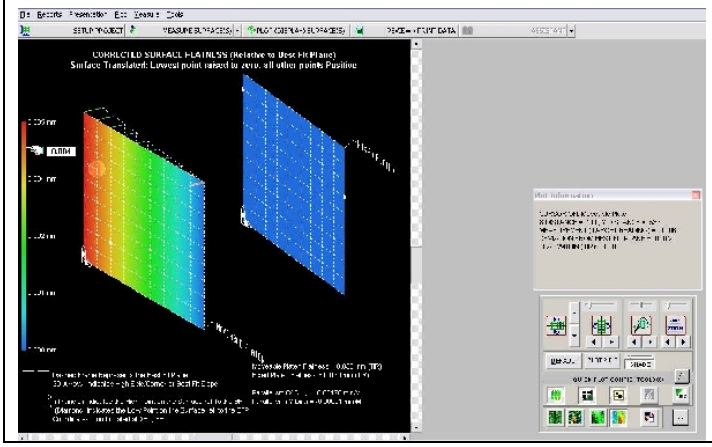


TAKING DATA

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.



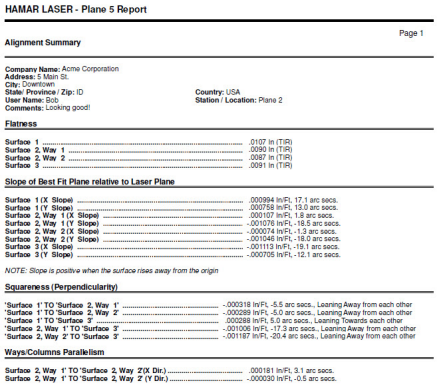


PLOTTING DATA

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.



HAMAR LASER - Plane 5 Report

Page 1

Alignment Summary

Company Name: Acme Corporation
Address: 5 Main St.
City: Downtown
State/ Province / Zip: ID
User Name: Bob
Comments: Looking good!
Country: USA
Station / Location: Plane 2

Flatness

Surface 1	.0107 In (TIR)
Surface 2, Way 1	.0090 In (TIR)
Surface 2, Way 2	.0087 In (TIR)
Surface 3	.0091 In (TIR)

Slope of Best Fit Plane relative to Laser Plane

Surface 1 (X Slope)	.000994 In/Ft, 17.1 arc secs.
Surface 1 (Y Slope)	.000758 In/Ft, 13.0 arc secs.
Surface 2, Way 1 (X Slope)	.000107 In/Ft, 1.8 arc secs.
Surface 2, Way 1 (Y Slope)	-.001076 In/Ft, -18.5 arc secs.
Surface 2, Way 2 (X Slope)	-.000074 In/Ft, -1.3 arc secs.
Surface 2, Way 2 (Y Slope)	-.001046 In/Ft, -18.0 arc secs.
Surface 3 (X Slope)	-.001113 In/Ft, -19.1 arc secs.
Surface 3 (Y Slope)	-.000705 In/Ft, -12.1 arc secs.

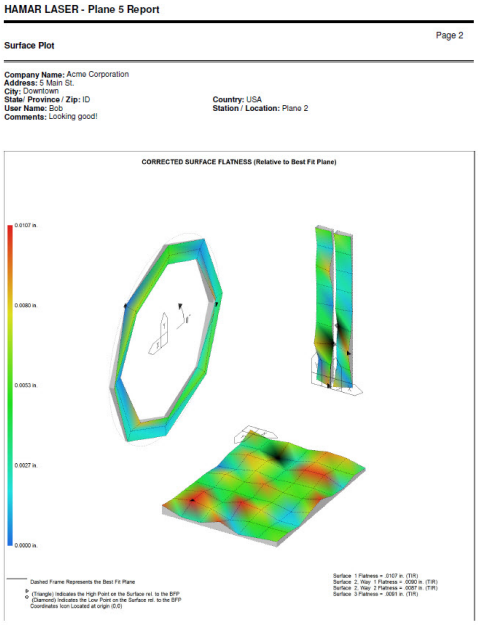
NOTE: Slope is positive when the surface rises away from the origin

Squareness (Perpendicularity)

'Surface 1' TO 'Surface 2, Way 1'	-.000318 In/Ft, -5.5 arc secs., Leaning Away from each other
'Surface 1' TO 'Surface 2, Way 2'	-.000289 In/Ft, -5.0 arc secs., Leaning Away from each other
'Surface 1' TO 'Surface 3'	.000288 In/Ft, 5.0 arc secs., Leaning Towards each other
'Surface 2, Way 1' TO 'Surface 3'	-.001006 In/Ft, -17.3 arc secs., Leaning Away from each other
'Surface 2, Way 2' TO 'Surface 3'	-.001187 In/Ft, -20.4 arc secs., Leaning Away from each other

Ways/Columns Parallelism

Surface 2, Way 1' TO 'Surface 2, Way 2'(X Dir.)	.000181 In/Ft, 3.1 arc secs.
Surface 2, Way 1' TO 'Surface 2, Way 2' (Y Dir.)	-.000030 In/Ft, -0.5 arc secs.



HAMAR LASER - Plane 5 Report

Page 2

Surface Plot

Company Name: Acme Corporation
Address: 5 Main St.
City: Downtown
State/ Province / Zip: ID
User Name: Bob
Comments: Looking good!
Country: USA
Station / Location: Plane 2

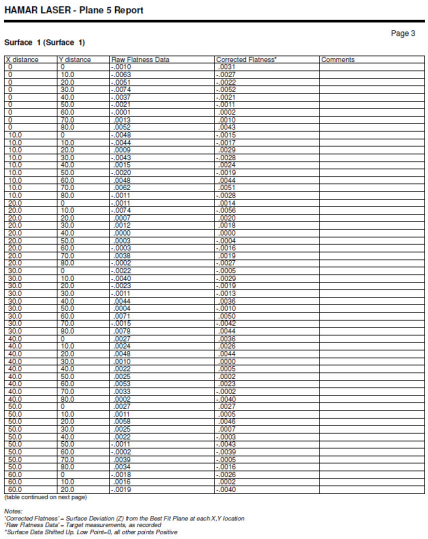
CORRECTED SURFACE FLATNESS (Relative to Best Fit Plane)

0.0107 in.
0.0080 in.
0.0053 in.
0.0027 in.
0.0000 in.

Dashed Frame Represents the Best Fit Plane

(Triangle) Indicates the High Point on the Surface rel. to the BFP
(Diamond) Indicates the Low Point on the Surface rel. to the BFP
Coordinates Icon Located at origin (0,0)

Surface 1 Flatness = .0107 in. (TIR)
Surface 2, Way 1 Flatness = .0090 in. (TIR)
Surface 2, Way 2 Flatness = .0087 in. (TIR)
Surface 3 Flatness = .0091 in. (TIR)



HAMAR LASER - Plane 5 Report

Page 3

Surface 1 (Surface 1)

X distance	Y distance	Raw Flatness Data	Corrected Flatness*	Comments
0	0	-.0010	.0031	
0	10.0	-.0063	.0027	
0	20.0	-.0091	.0022	
0	30.0	-.0074	.0052	
0	40.0	-.0037	.0021	
0	50.0	-.0021	.0011	
0	60.0	-.0001	.0002	
0	70.0	.0013	.0010	
0	80.0	.0062	.0043	
10.0	0	.0048	.0015	
10.0	10.0	-.0014	.0017	
10.0	20.0	.0009	.0029	
10.0	30.0	-.0043	.0026	
10.0	40.0	.0015	.0024	
10.0	50.0	-.0020	.0019	
10.0	60.0	.0048	.0044	
10.0	70.0	.0062	.0051	
10.0	80.0	-.0011	.0028	
20.0	0	-.0011	.0014	
20.0	10.0	-.0074	.0056	
20.0	20.0	-.0007	.0020	
20.0	30.0	.0012	.0018	
20.0	40.0	.0000	.0030	
20.0	50.0	-.0003	.0004	
20.0	60.0	-.0003	-.0016	
20.0	70.0	.0038	.0019	
20.0	80.0	-.0002	-.0027	
30.0	0	-.0022	-.0005	
30.0	10.0	-.0040	-.0029	
30.0	20.0	-.0023	-.0019	
30.0	30.0	-.0011	-.0013	
30.0	40.0	.0044	.0038	
30.0	50.0	.0004	-.0010	
30.0	60.0	-.0071	.0050	
30.0	70.0	-.0015	-.0042	
30.0	80.0	.0078	.0044	
40.0	0	.0057	.0026	
40.0	10.0	.0024	.0025	
40.0	20.0	.0048	.0044	
40.0	30.0	.0010	.0000	
40.0	40.0	.0022	.0005	
40.0	50.0	.0025	.0022	
40.0	60.0	.0053	.0023	
40.0	70.0	.0033	-.0002	
40.0	80.0	.0002	-.0040	
50.0	0	.0027	.0027	
50.0	10.0	.0011	.0005	
50.0	20.0	.0058	.0046	
50.0	30.0	.0025	.0007	
50.0	40.0	.0027	.0008	
50.0	50.0	.0011	-.0043	
50.0	60.0	-.0002	-.0039	
50.0	70.0	.0039	-.0005	
50.0	80.0	.0034	-.0016	
60.0	0	-.0018	-.0026	
60.0	10.0	.0016	.0002	
60.0	20.0	-.0019	-.0040	

(table continued on next page)

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

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.