CORRECTED SURFACE FLATNESS (Relative to Best Fit Plane)

0.0104 in.

.008

0.0078 in.

0.0052 in.

0.0026 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 = .010 in. (TIR)
Surface 2, Way 1 Flatness = .010 in.
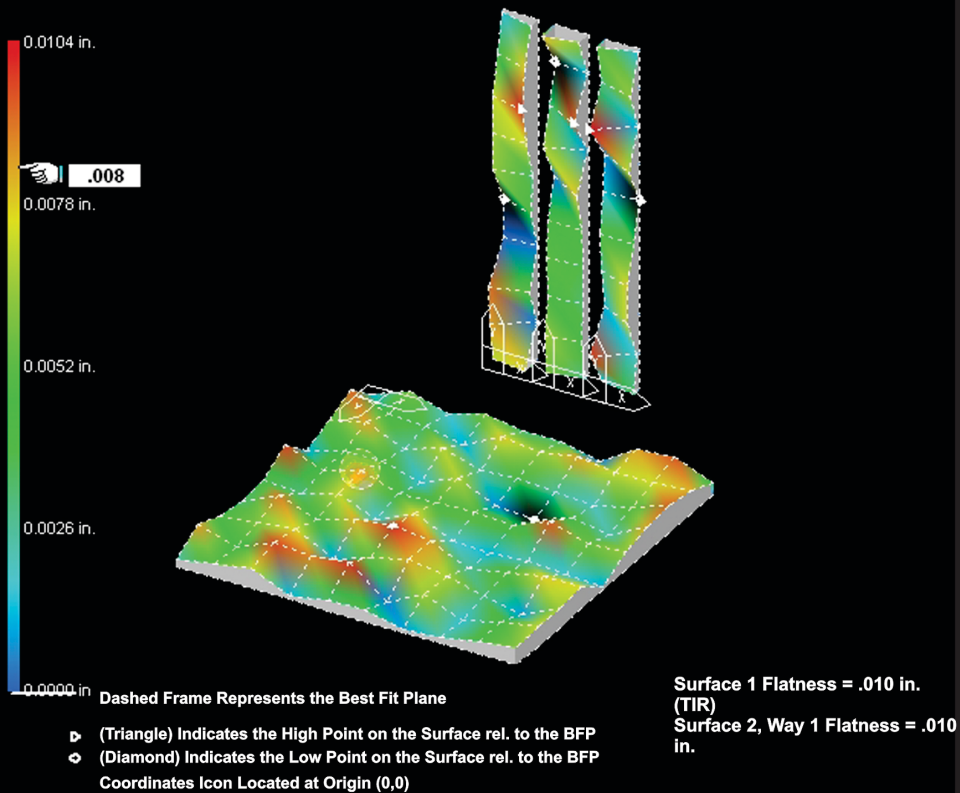
Operations Manual

PLANE5

March 2019

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ALIGN WITH THE BEST

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Introducing Plane5

Hamar Laser's Plane5 software analyzes almost any layout for flatness, squareness and parallelism. Surface shapes, such as squares, rectangles, frames, circles, rings, and up to five sets of ways can be easily analyzed and plotted using 3-D graphs. The software is compatible with all of Hamar Laser's old and new continuously-rotating lasers, and several different target/interface combinations can be used to download data.

By using the Moody Method layout for surface plate measurement, the Plane5 software provides a direct comparison to existing methods of measuring surface plates, such as electronic levels, interferometers and autocollimators. Up to three surfaces (one horizontal and two vertical) can be graphed and analyzed in the same file. The plots show the least-squares, best-fit plane with shaded graphs to indicate high and low points, grid lines and the slope high point of the best-fit plane.

Figure 1 – *Raw Surface Profile, as measured*

Variable zooming and rotation capabilities allow small sections of surface plots to be analyzed in either coarse or fine mode. The *Surface Elevation Scale* is displayed as two walls behind the plotted surface, with a color scale indicating the relative values of each color on the plot. The *Surface Annotation Feature* displays X, Y and Z dimensions to any measured point on the plot surface. Multiple plot presentation methods, such as *Raw Surface Flatness* (as measured), which shows data relative to the laser plane and best fit plane, *Surface-to-Best-Fit Plane*, which shows how far each data point is from the best-fit plane (after performing the Least-Squares, Best-Fit analysis) and *Best-Fit to Laser Plane*, which shows how far out of parallel the best-fit plane is from the laser plane are included in the program.

The program automatically checks for and loads information for the connected target and interface. A random data mode is available for running the program without hardware, which is useful for training or software familiarization before performing an actual alignment. In addition, Plane5 generates reports that may be saved and printed. These reports can include graphs of the plot, data tables for single or multiple surfaces, and comparisons of multiple surfaces.
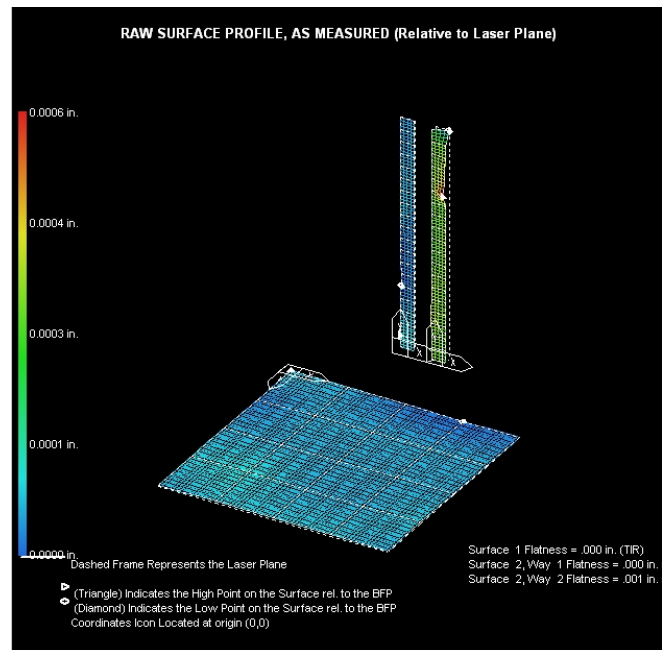
Installing and Running Plane5 in Windows7

Plane5 may have difficulty accessing certain folders in Window7. To prevent these difficulties, install and configure Plane5 as follows.

1. Install the Plane5 software.

2. From the Windows Start Menu, click **All Programs**.

3. Locate and click on the Plane5 Version II folder to display the contents (*Plane5* and *Update Utility*).

4. Right-click *Plane5* and select **Properties** from the pop-up menu. Note that other items in your program menu will differ.

5. When the Plane5 properties display, click the **Compatibility** tab.

6. Set the following options:
   - Run this program in compatibility mode for Windows XP (Service Pack 3).
   - Run this program as an administrator.

7. Click **Apply** to save the settings.
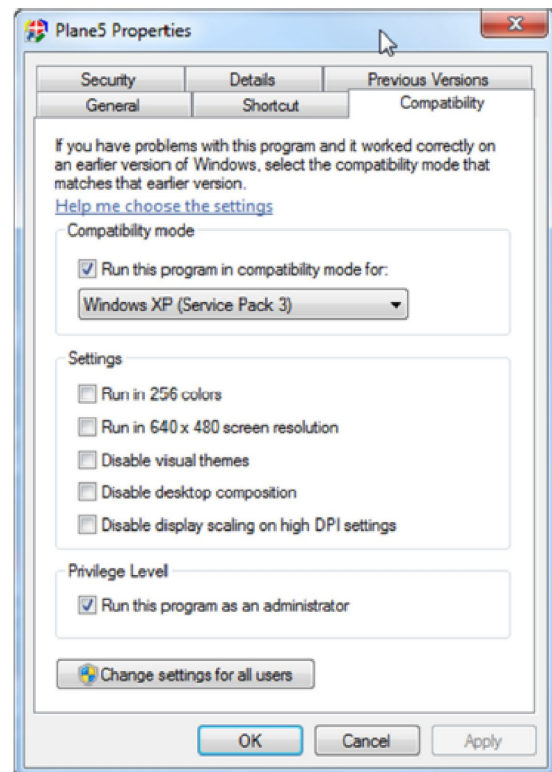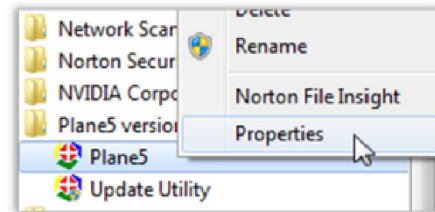
Using Plane5

Plane5 consists of five main steps: selecting program options, defining a project, taking data, plotting data and generating reports. When Plane5 opens, the **Program Options** menu displays, allowing changes to how the program works.

Selecting Program Options

The General Tab
Click the **General** tab to set preferences for displaying messages and saving backup files. In addition, this menu contains a slider bar to set program performance in relation to background applications that are running on the computer.
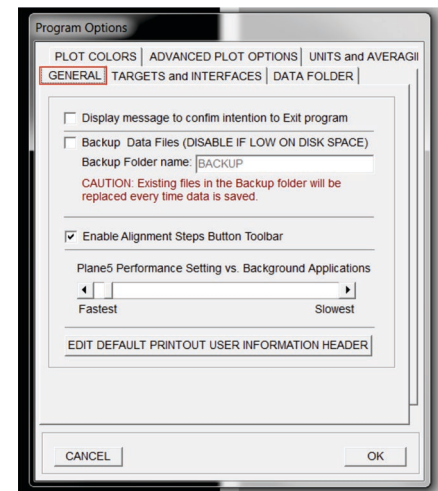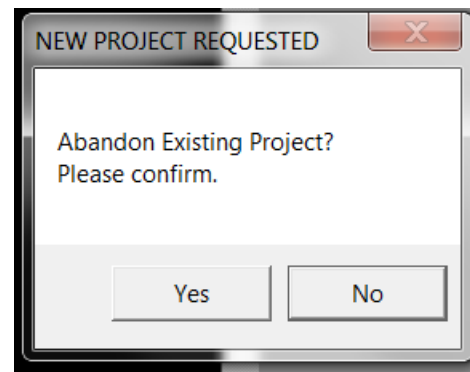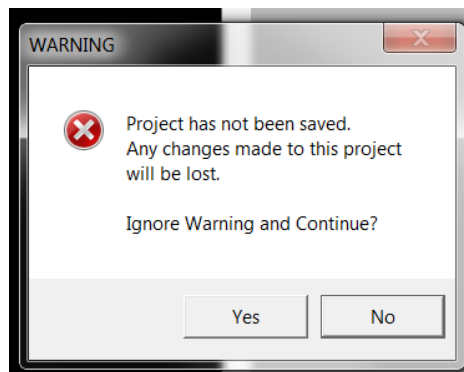

The Alignment Steps Button Toolbar

Check **Enable Alignment Steps Button Toolbar** to enable or disable the alignment toolbar. This toolbar provides a convenient way to access program features.
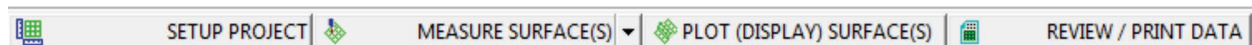

- Click **Setup Project** to set up a new project. Messages are displayed prompting to either save or abandon the current project before setting up a new project.

- Click **Measure Surfaces** to display the **Measuring Assistant**. This is a help screen, providing step-by-step instructions for selecting and measuring points, measuring options and selecting surfaces. Click *Do Not Show the Measuring Assistant Next Time* to disable Measuring Assistant and display the Surface 1 Data Taking Screen.
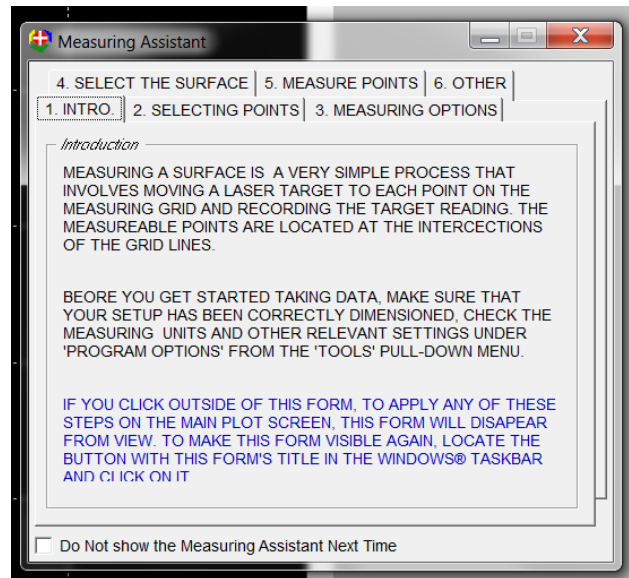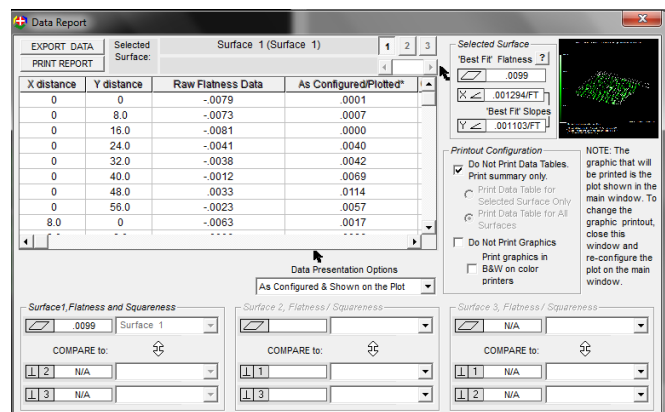

- Click the down arrow next to **Measure Surfaces** to select the surface to be measured.
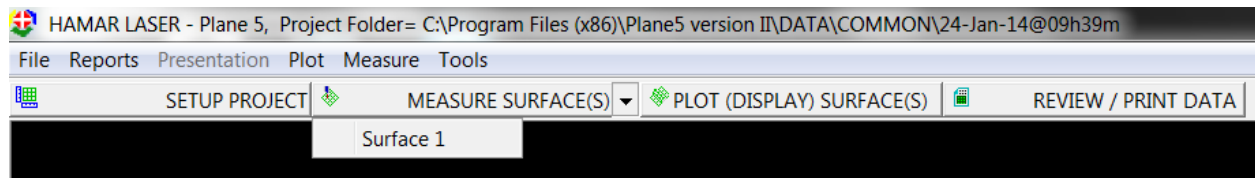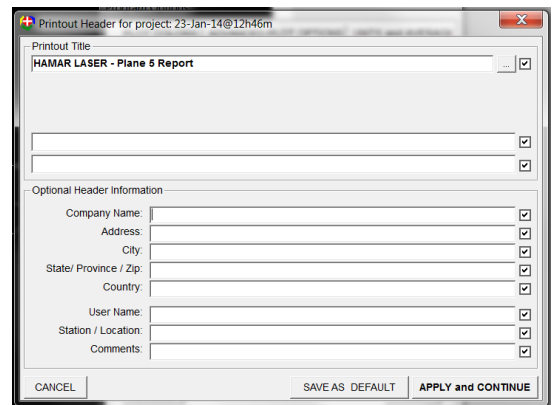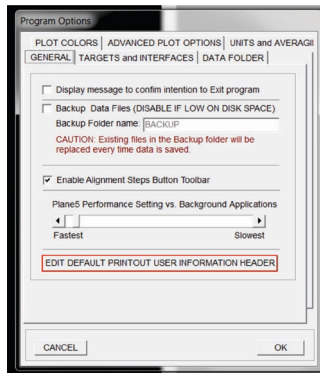

- Click **Plot (Display) Surface(s)** to display the Isometric All Surfaces plot, showing all surfaces that have been measured.
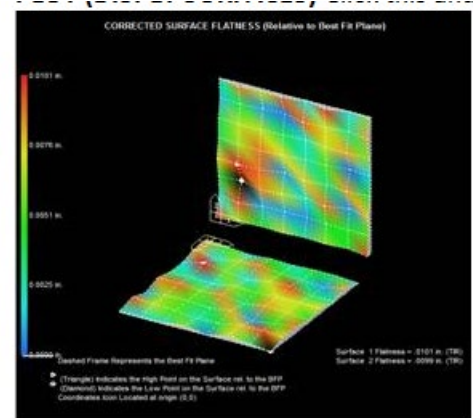
- Click **Review/Print Data** to review the data and print a report.

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Also located on the **General** tab is **Edit Default Printout User Information Header** to customize plot printouts.
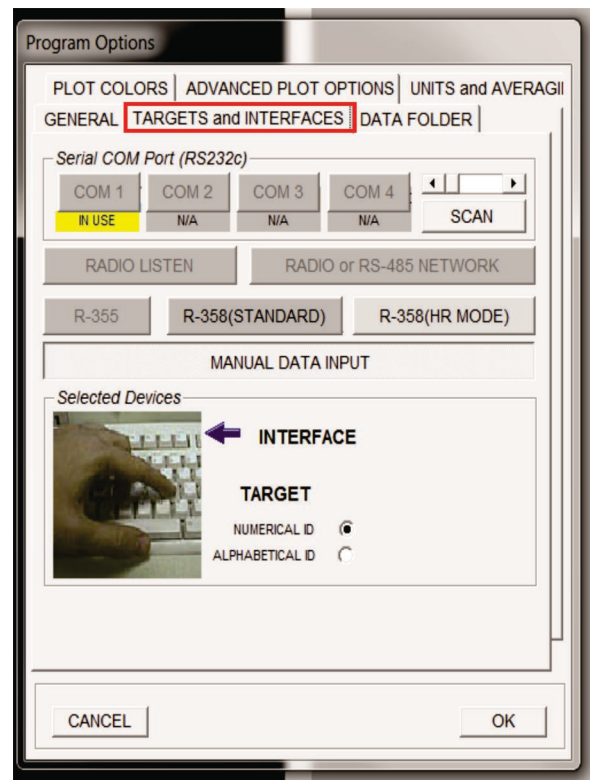

The Targets and Interfaces Tab

When Plane5 starts, it scans for the target and interface connected to the computer and automatically selects the detected items when the Program Options screen displays. If an interface is *not* detected, the program automatically sets the data acquisition default to *Manual Data Input*. This is designated by a keyboard picture as the selected device.

The following procedure can be used to manually reconfigure the interface and target. You may skip these steps if the target and interface was identified correctly.

- If you know the COM port (serial port) used by your computer to connect to the Hamar Laser interface, click on the COM port button to initialize it
- Connect the Interface. If the interface has a power switch, turn it on. Click **Scan** to attempt to locate and identify an interface connected to any available serial port. If an interface is not recognized automatically because it is not connected to the computer, click on the appropriate interface selection button.
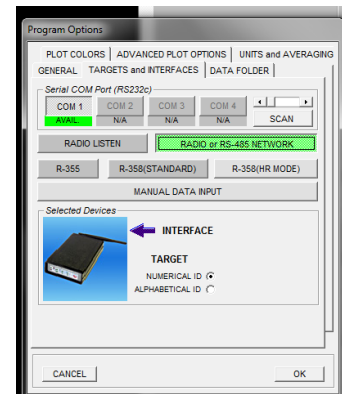
Selecting an Interface

Radio Listen
Select **Radio Listen** to use the R-1310 Receiver on a handheld PDA. The R-1310 transmits to the target(s) and Plane5 will "listen" for the data.

Radio or RS-485 Network
When this selection is made and COM 1 is the active COM port, a picture of the R-910 Radio Interface displays. Compatible targets for this selection are the A-1519-2.4ZB and the A-1520-2.4ZB. If the interface is connected to a COM port other than COM 1, select the appropriate COM port.

R-358 Interface/R-358 HR Mode
This selection displays an image of the R-358 Interface. Ensure that you have selected the correct interface, or no data will display on the screen. These interfaces are used with the A-517 Target.
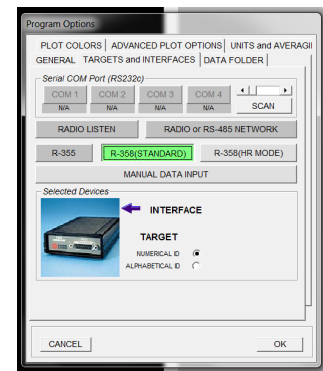
Selecting an Interface for Infrared Targets
When using Hamar Laser's older A-1519 IR targets, select the R-358 (Standard) Interface. These targets are identified *alphabetically*, so ensure that the Alphabetical ID box is checked when using these targets.
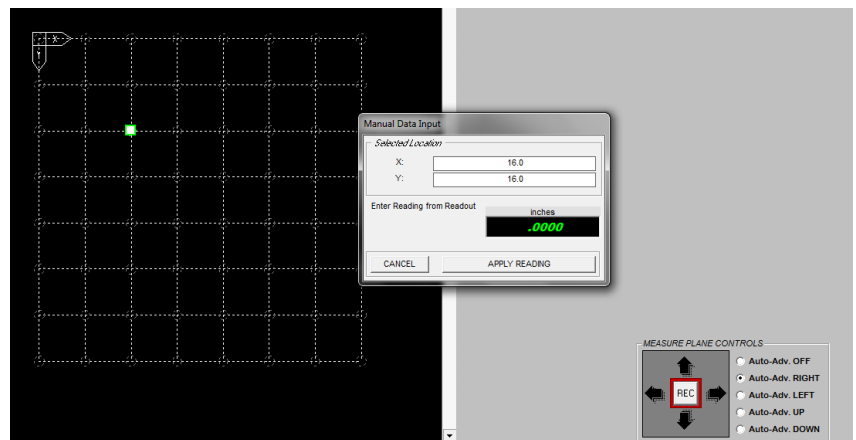
Manual Data Input Mode

Select **Manual Data Input** mode to run Plane5 without targets or interfaces. This is useful for training purposes, to become familiar with the program, or to enter data from a readout.

Before using **Manual Data Input** mode, a new project must be set up. See *Setting up a New Project* beginning on Page 10 for further information.
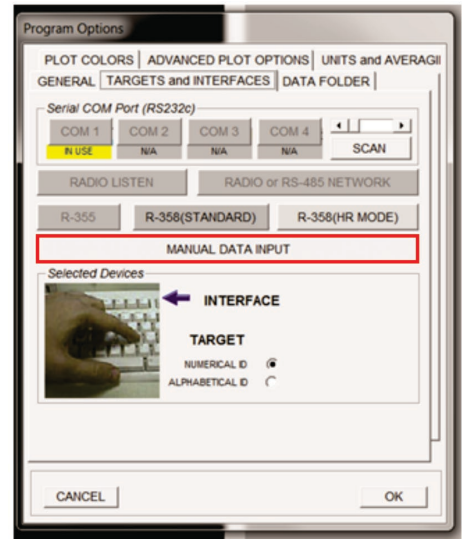

When the measuring screen displays, double-click on any point on the surface. Press the spacebar or click the **REC** (Record) button to bring up the **Manual Data Input** box. Click **Apply Reading** when the data is entered.
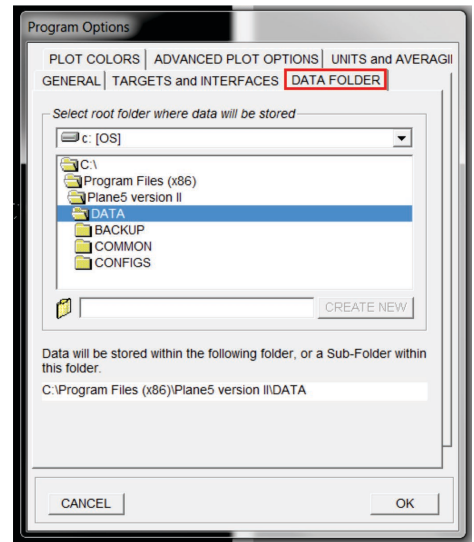

Random Data Mode

A plot may also be filled with *random* data when using **Manual Data Input** mode by double-clicking any point on the surface and hitting the **R** key. Click **Yes** to fill the plot with random data.
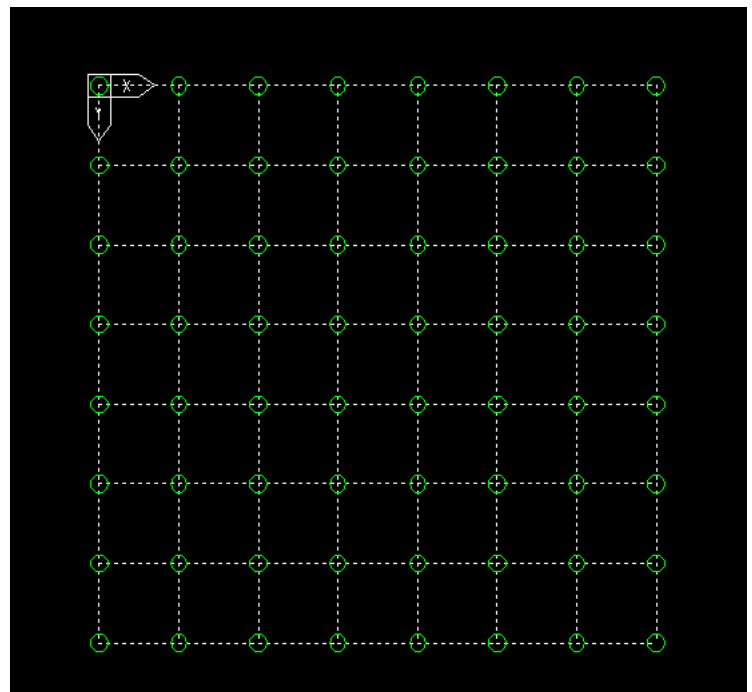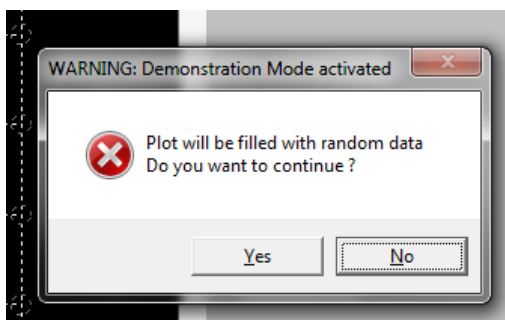
The Data Folder Tab

Select **Data Folder** to specify the folder where Plane5 saves collected data.

The Plot Colors Tab

Select **Plot Colors** to change the background used when printing plots (black or white) or to change the line color for each plane. Click on the *label* for a plane (Plane 1, Plane 2, Plane 3) to open the Color Selection menu. Click **Apply** when the selection has been made.
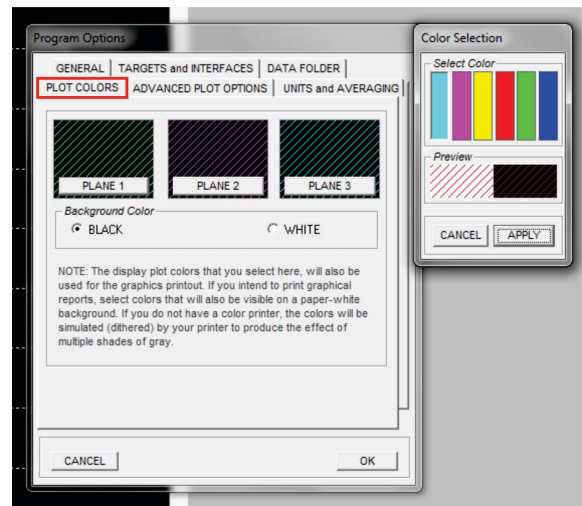
The Advanced Plot Options Tab

Select **Advanced Plot Options** to change the graphic resolution for circles and arcs for faster drawing. Circles and arcs will not be defined with lower resolution settings.

Select an option in **Surface Plot Shading** to disable or select single or multiple colors for shading plots.

Coordinate System (Hamar Default) places the X-zero and Y-zero coordinates in the upper left hand corner of Surface 1, the lower left corner of Surface 2, and the lower right corner of Surface 3 on the plot screen.
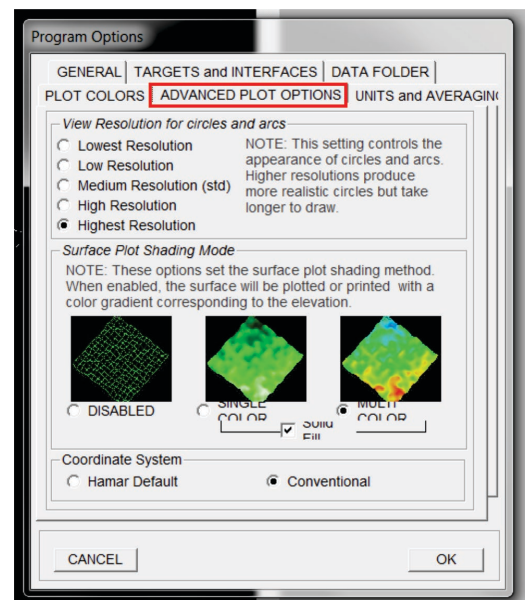
The Units and Averaging Tab

Select **Units and Averaging** to select measurement units, the number of readings to average and the number of decimal places to be displayed when using Plane5.

- Select the **Measurement units** (English or Metric).
  Note: If data is loaded from a saved project, the program will not allow the measurement units to be changed unless a new project is started. This is intended to prevent mixing measurement units within a project.

- Select the N**umber of Decimal Places** using the **Display Resolution** scroll bar.
  Note: Selecting fewer decimal places than what the interface or target resolution allows does not limit the accuracy of the measurements. The program processes data internally at the measuring device's full resolution. The number of decimal places only determines how many zeroes are displayed to the right of the decimal point. For example, to display data showing measurement data rounded off to the nearest .001 in., set the number of decimal places to 3.

- Select **Number of Samples** using the **Averaging** scroll bar. The live target reading displays the running average of the last number of reading samples. For example, if using five samples, the reading displayed is a running average of the last five readings received. The running average works as follows. As each new reading is received, the oldest reading sample is discarded, and the new reading sample takes its place. A new average is calculated consisting of the four oldest reading plus the new reading divided by 5.
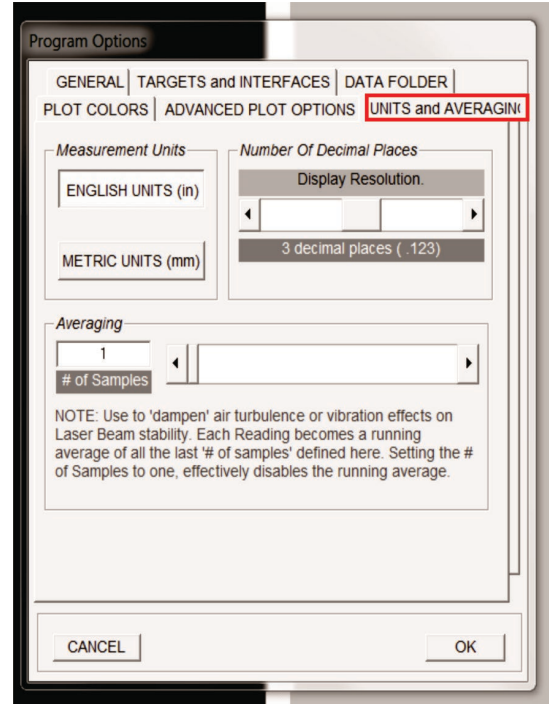
Project Selection

Once the **Program Options** have been selected, click **OK.** You will be prompted to:
- Set up a new project
- Start a new project using a previously saved file as a template (a template contains setup information only—no data)
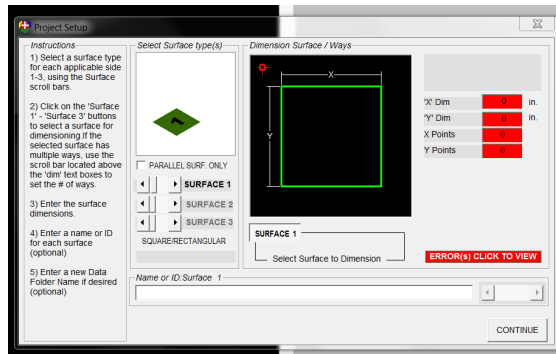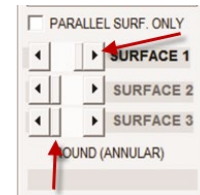- Load an existing project that has been previously saved.

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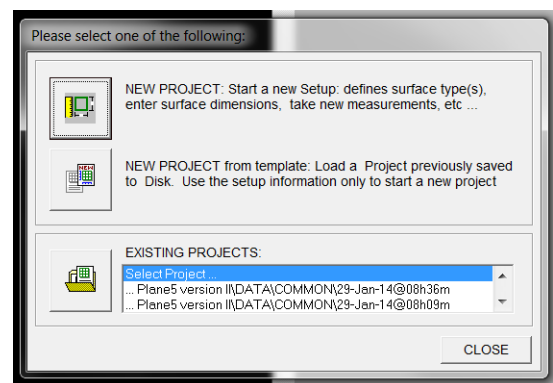
Setting up a New Project

Selecting Surface Type(s)

To begin setting up a new project, select a surface type that reflects the alignment being performed. Three orthogonal surfaces may be selected. Using the scrollbar or arrow key next to each **Surface** number, select one of the following choices:


Square/Rectangular – surface plates, machinery tables or any surface that has a square or rectangular shape
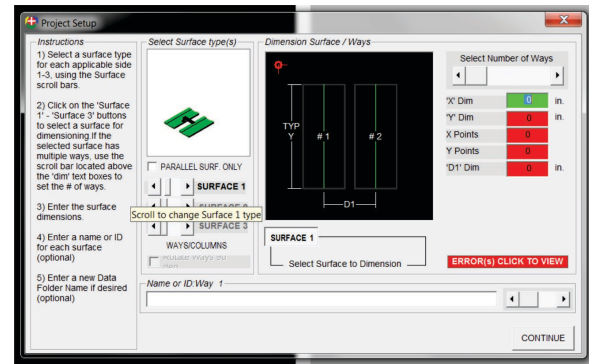
Ways/Columns – up to five machine ways or columns can be measured simultaneously
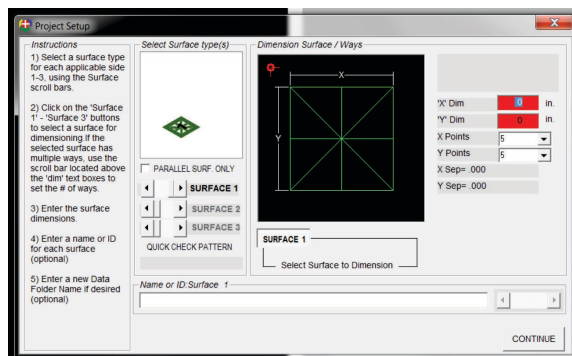
Moody Method – this represents the Moody Method of measuring the flatness of a square or rectangular surface, which is typically used with autocollimators, interferometers, and electronic levels
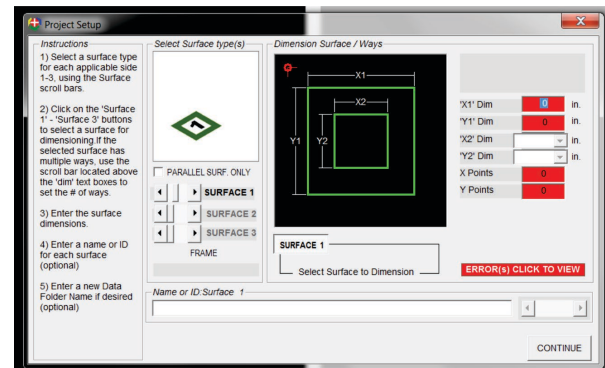
Square Flange (Frame) – this represents a square flange or frame
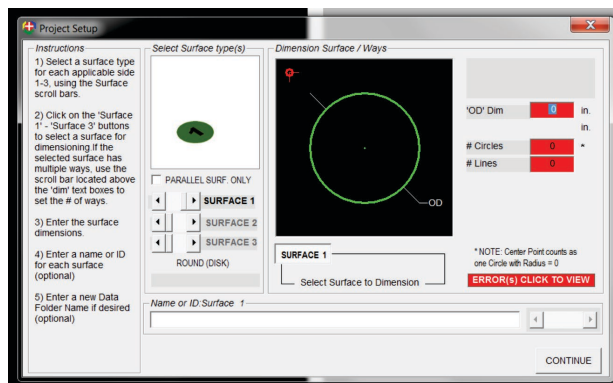
Round Surface (Disk) -- used to measure the flatness of the table of a Vertical Turning Center or similar round surface
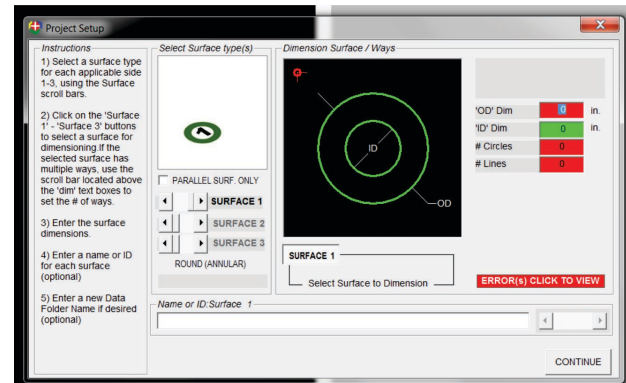
Round Flange (Annulus) -- used to measure large flanges, such as windmill tower flanges or crane bearing surfaces

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In the following example, the project is comprised of two surfaces: a simple square or rectangular plane on Surface 1 and two columns on Surface 2.

1. Select the Surface 1 type using the **Surface 1** scrollbar. In this example, a simple square/rectangular surface was selected.
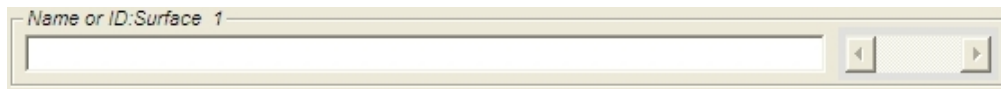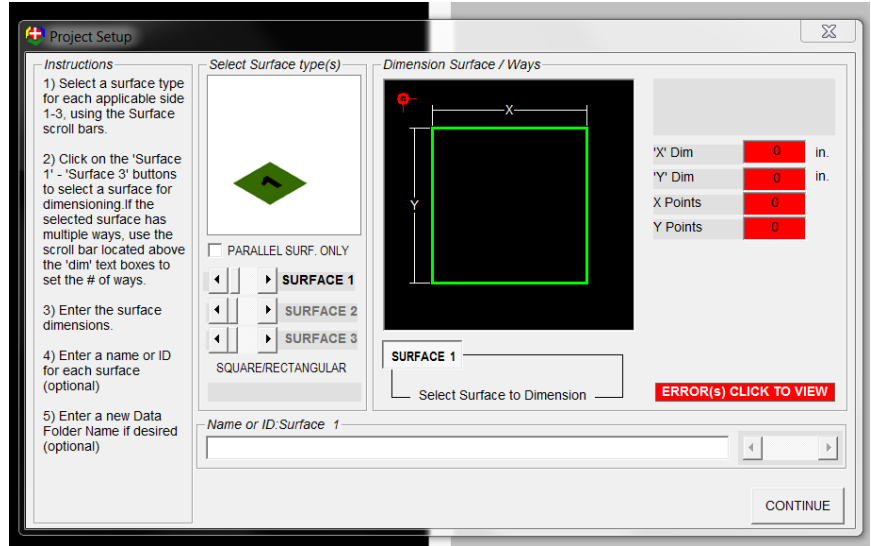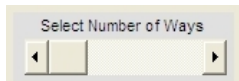2. Enter a name to identify the surface (optional). Surface 1, Surface 2 and Surface 3 are the default names.

3. Select the Surface 2 type using the **Surface 2** scrollbar. In this example multiple ways/columns were selected.
4. Select the number of ways/columns for Surface 2 using the scrollbar. This scrollbar is enabled for ways/columns surface types only.

5. Enter a name for Surface 2 (for example, Surface 2, Way 1). Use the scrollbar to select the Way/Column to name.
6. When surface selection is complete, click **Continue.**
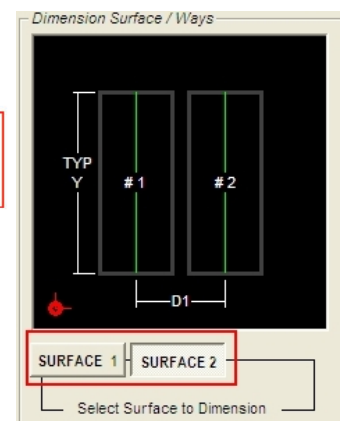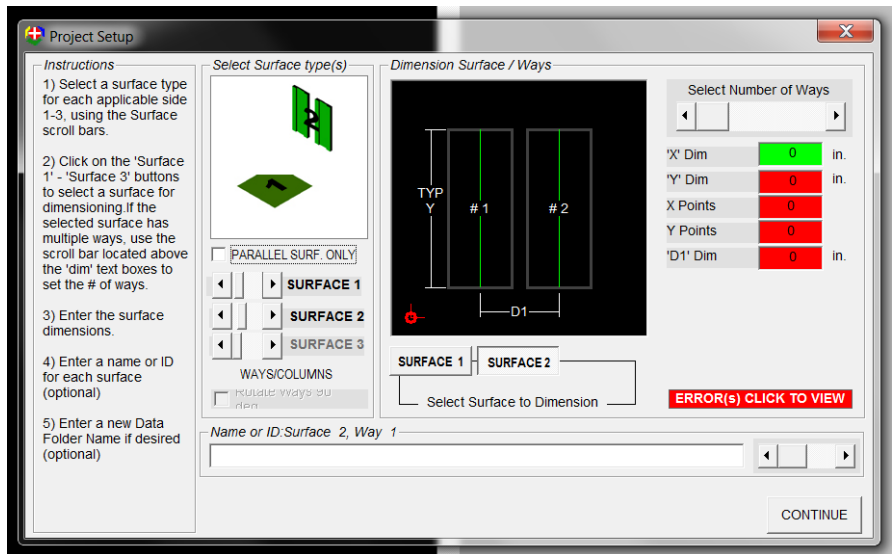

NOTE: After selecting and naming the surfaces, do not use the surface type selection scroll bars unless you intend to change the surface type. You will lose the settings previously entered. Use the **SURFACE 1 … SURFACE 3** *buttons to select the surface to name and dimension (see* Figure 2).

Figure 2 – *Surface selection buttons*

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Entering Dimensions

1. Select Surface 1 for dimensioning by clicking on the **SURFACE 1** button.
2. Enter the dimensions for Surface 1 in the dimension fields. Press **ENTER** after entering a value in a dimension field.
3. Select Surface 2 for dimensioning by clicking the **SURFACE 2** button.
4. Enter the dimensions for Surface 2 in the dimension text fields. Press **ENTER** after entering a value in a dimension field.
5. Click **Error(s) Click to View** to display missing data or parameters that are outside of the allowable range. *This bar is only visible when setup errors exist.*

*Note: Green text fields indicate that the values entered are valid. Click **CONTINUE** when finished.*

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Measuring a Surface and Taking Data

1. From the **Measure** menu, select the surface to be measured. The main plot area displays a grid that represents the plane view of the surface to be measured.

2. If the measuring target has not been selected, select it by pressing one of the buttons on the lower right of each target display. The selected measuring target is identified by an arrow pointing to the target number (see Figure 4).
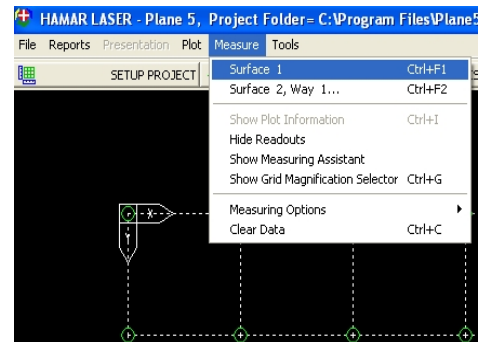
3. Surface measurements are taken at any intersection of two lines on the measuring grid. To measure a point on the surface, move the mouse cursor to an intersection on the grid. Note that the cursor changes from a cross to a target icon to indicate that the cursor is located at a measurable location. Double-click on the measurable location to mark the starting point. A solid dot (measurement cursor) displays to make the selected measurement location easy to identify, and

   Auto Advance and Record buttons are available on the **Record** screen.

Figure 3 – *Selecting the Measuring Target*

4. To advance to the next point of the grid after recording a measurement, select Auto-Advance mode under *Measurement Options*. For example, to auto-advance to right of the previous point, select *Auto-Advance Right.* The measurement cursor moves in the selected direction until it is overridden with an arrow key on the computer keyboard or Auto-Advance is disabled.
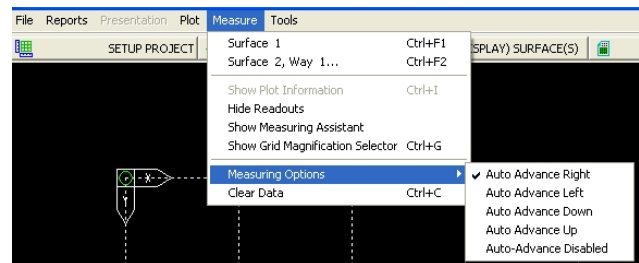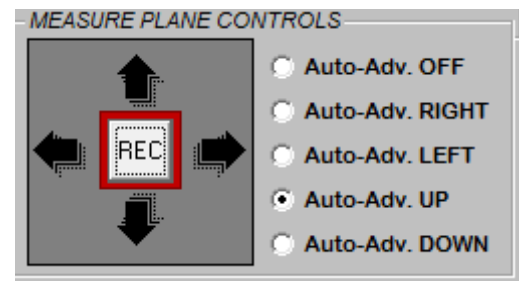
5. To record the target measurement at the selected location, ensure that the target is physically located at the selected point on the computer screen. After moving a target to a new location, allow the target reading to stabilize, especially when averaging is set to a high number of samples.
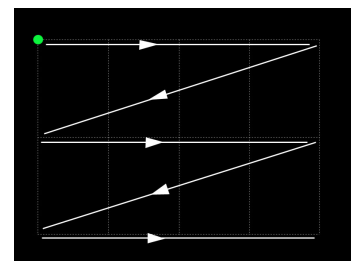
Figure 4 – *Path of data points when Auto-Advance Right is selected*

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MEASURE PLANE CONTROLS

Press the **SPACEBAR** or click **REC** to record data. If a point is recorded with the target at the wrong location, retake the data.
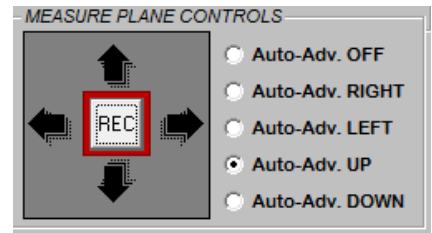
6. Points that have already been measured are identified by a circle, about half the size of the measurement cursor. If the measurement cursor is placed over a point that has already been measured, the shape changes from square to round.
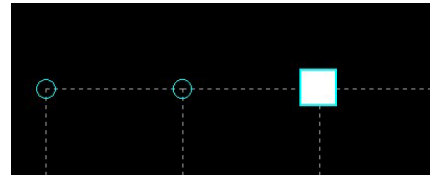
7. Repeat Steps 1-5 until all surfaces are measured. It is advisable to save the data after measuring each row/column of points. Data may be saved as frequently as desired during a measurement session.

8. If more than one surface needs to be measured, click **MEASURE** and select the next surface to be measured.
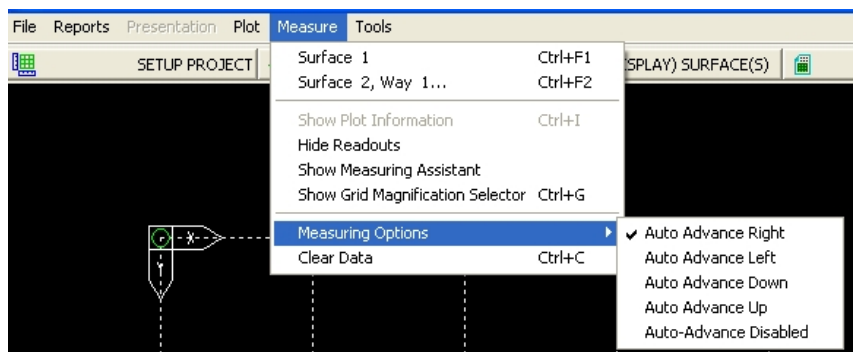
Deleting Points from a Measurement Surface

1. From the **Measure** menu, select the surface to be altered.
2. Move the cursor to a point above and to the left of the point(s) to be deleted. Hold the **Ctrl** key and left mouse button down together and pull the cursor down and to the right. A dotted red line will form around the point(s) to be deleted.
3. Release the left mouse button and the **Ctrl** key. A popup window displays.
4. Select either **DELETE Point(s)** or **Exclude Point(s) from Calculations** and click **Apply**. Selecting **DELETE Point(s)** deletes the point(s). If **EXCLUDE Point(s) from the Calculations** is selected, the points will remain on the plot but will not be calculated in the results.
5. Confirm the action by clicking **OK**.
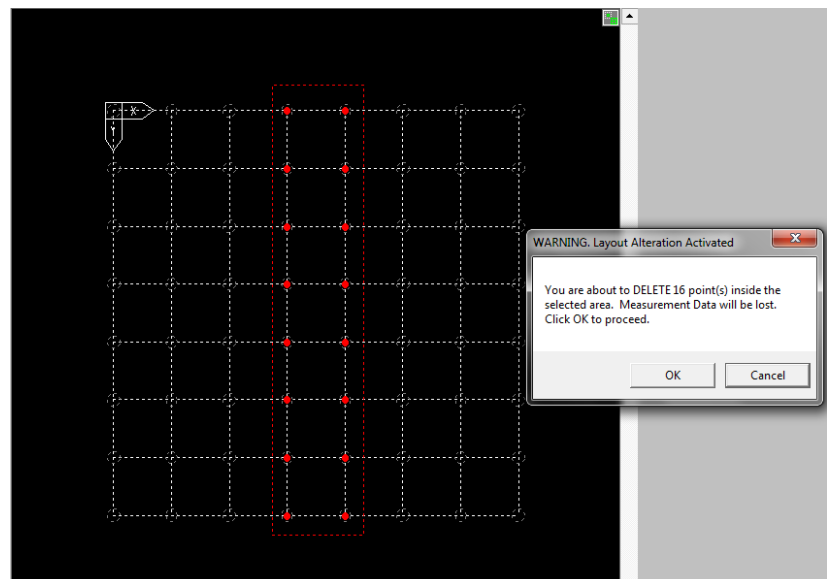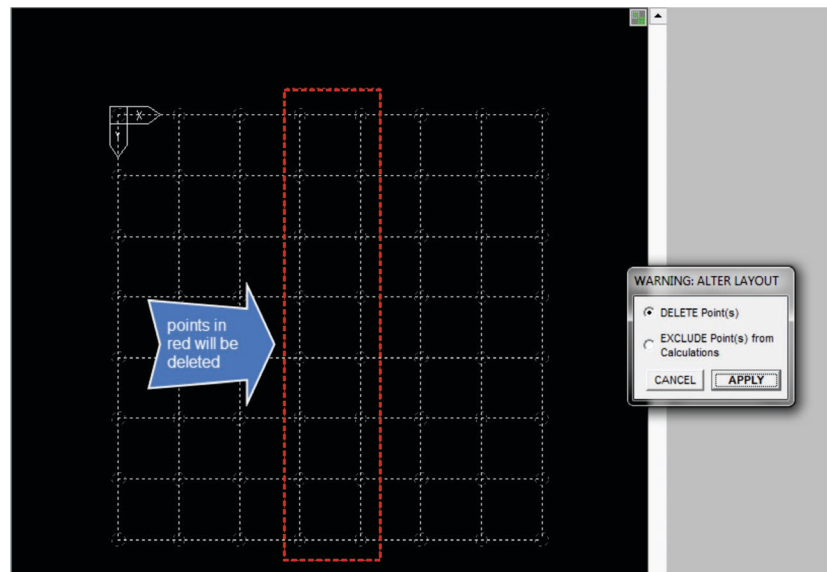
6. To delete or exclude additional points, repeat Steps 2-5.
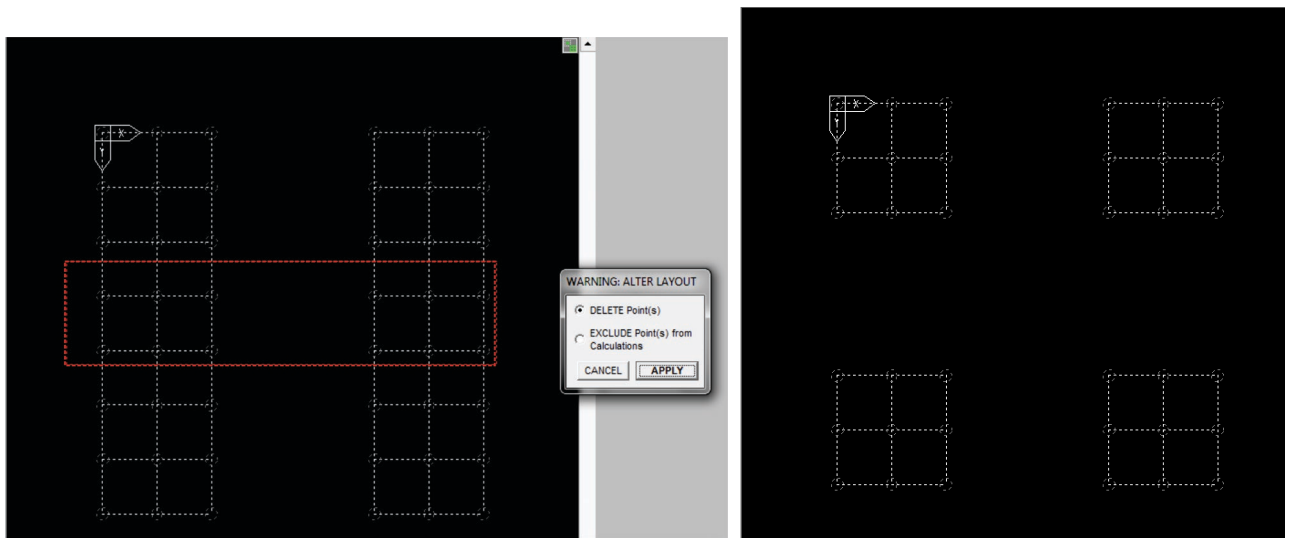
7. After taking data, click **Plot Surface(s)**. The flatness plot displays, as shown below. Note that the flatness data specified is the *overall* flatness of all the points recorded in the Measure Screen.
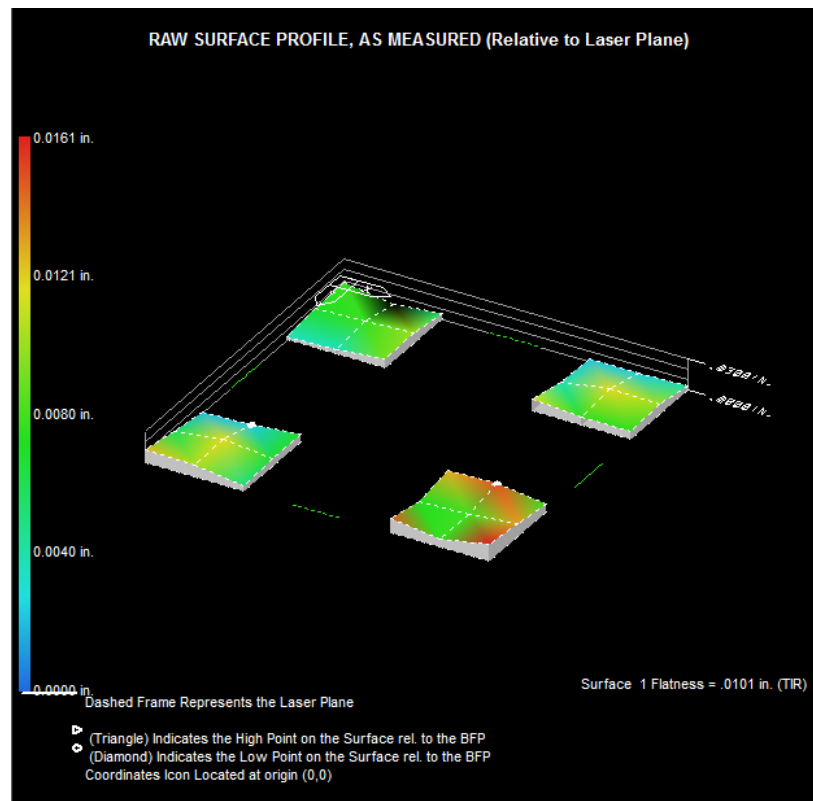
Zooming in on a Surface

If there are many points to be measured on a surface, it is often difficult to identify a measurement location on the grid. Click the icon in the upper right corner of the Measure Screen to enable the **Zoom** feature.
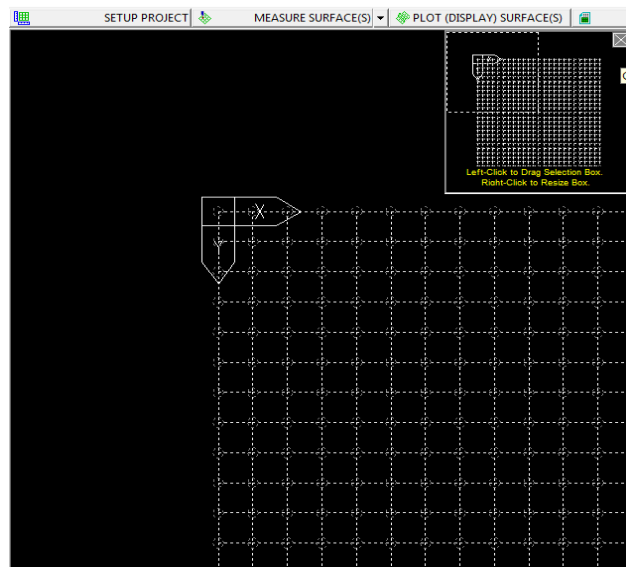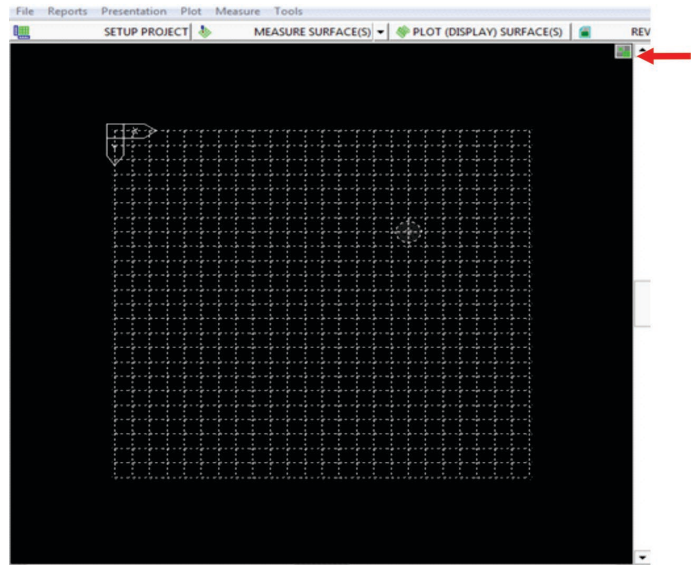
A representation of the screen displays with a box highlighting the X-zero and Y-zero coordinates. Left-click on this box with the mouse and drag to any area of the grid to zoom in.
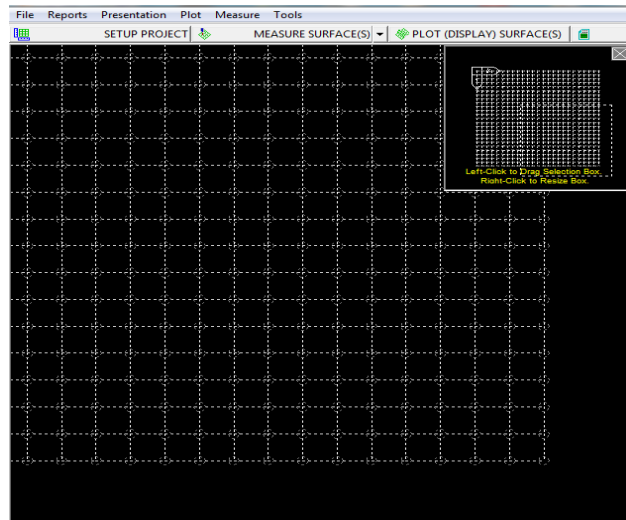
Annotating a Surface

Right-click anywhere on a measured grid or plotted surface to display a menu to annotate the surface. The specific surface may be selected from this menu and a plot may be generated from a measured grid.

1. Double-click **Annotations**.

2. Hold the **Alt** key and click on any point of the surface to display the **Surface Annotations** screen (see Figure 5).
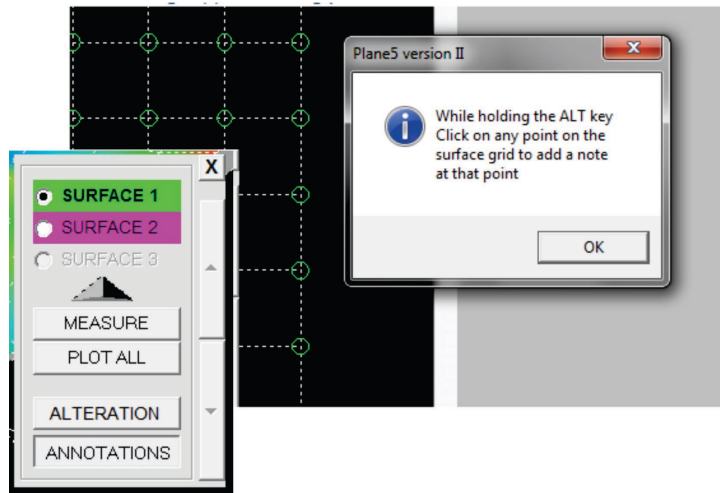
3. Select an annotation to add to the point from the list or click **Other** to add a new annotation. Click **Apply** to add the annotation to the surface. In the example, *Start Point* is added.

4. Other selections from the **Surface Annotations** screen include specifying the text direction for the annotation, editing annotations, and clearing all annotations from the surface.
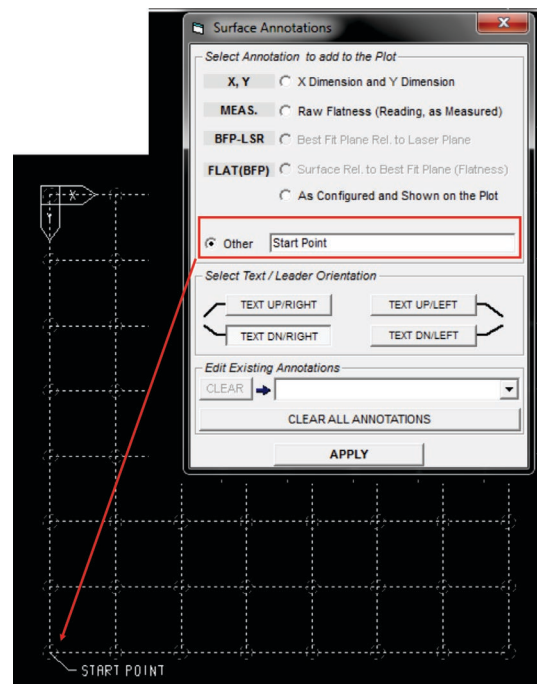
Figure 5 – *Annotating a Surface*

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Measuring and Plotting Parallel Surfaces

Plane5 provides an option for measuring the parallelism of two surfaces. The parallelism options are two horizontal rectangular surfaces, two vertical rectangular surfaces, or two vertical, round flange-type surfaces.

1. To set up a parallel surface project, click the **PARALLEL SURF. ONLY** box in the Project Setup Screen.
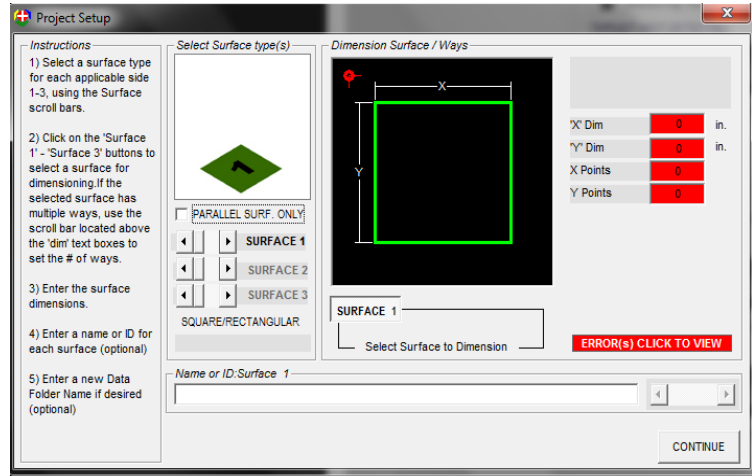
2. When **Parallel Surf. Only** is clicked, the Setup Screen displays two horizontal surfaces. Click **Type** to scroll through the options for parallel surfaces and select the one that is applicable to your project.

Parallel Surfaces Only Types
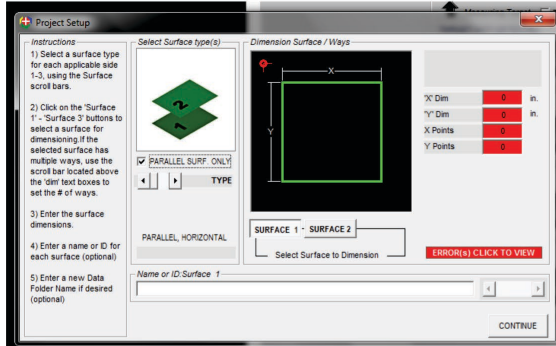
Two Horizontal Planes
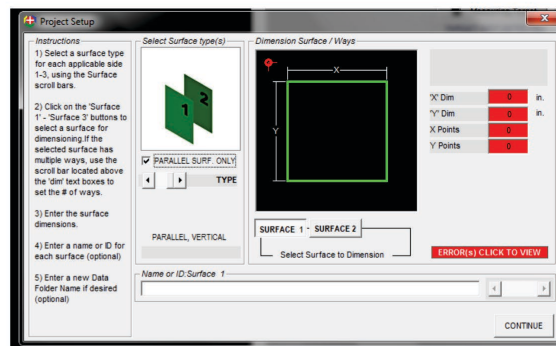
Two Vertical Planes
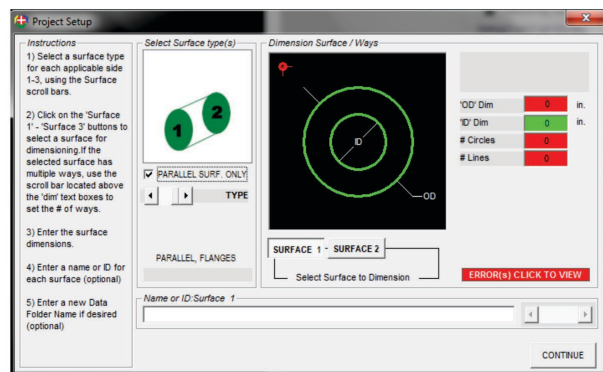
Round Vertical Flange-Type Surfaces

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3. Enter the dimensions for Surface 1 as described in *Entering Dimensions* on Page 12.

4. Click **Surface 2** and enter the dimensions for the second surface.

5. Click **Measure** and select either Surface 1 or Surface 2.
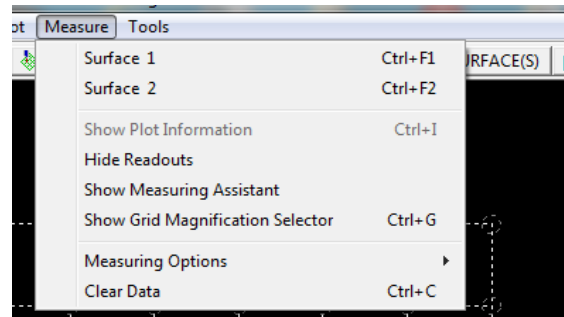
6. The **Measure** screen displays with the parallel surfaces image in the upper left corner. The surface to be measured is labeled. Take measurements at each measurement point as described in *Measuring a Surface* beginning on Page 13.
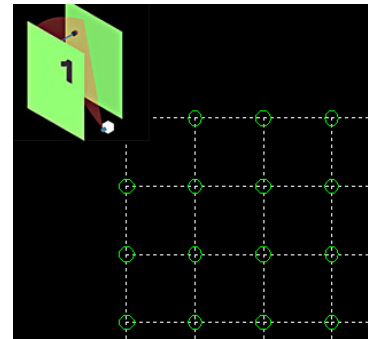
7. Click **Measure,** select the other surface, and repeat the process for measuring a surface.
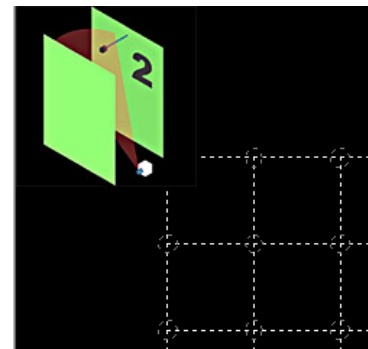
Note: *Plane5 always places the laser in the corner where all three surfaces meet, and this is where the X-zero and Y-zero coordinates will be located on all surface images. The X-zero/Y-zero coordinate is in the upper left corner of Surface 1, in the lower left corner of Surface 2, and the lower right corner of Surface 3.*
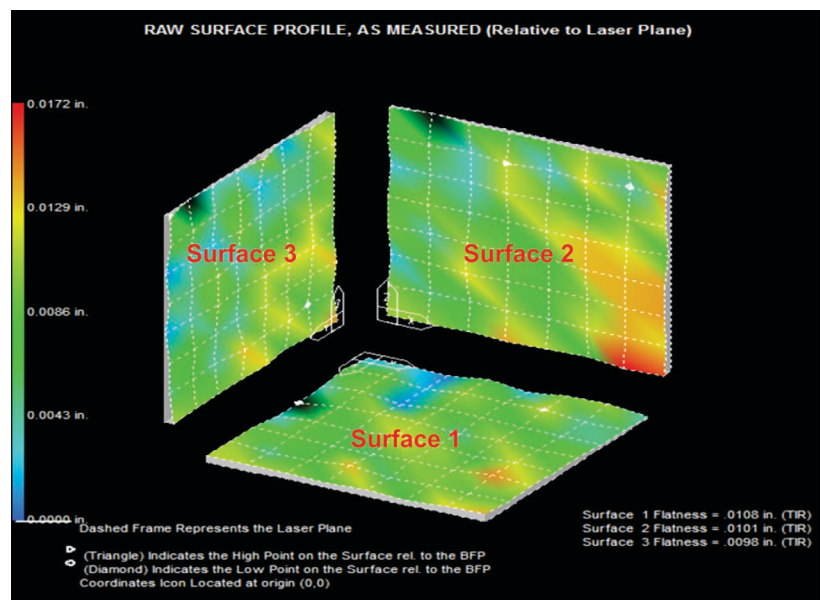
8. After both surfaces have been measured, click **Plot** at the top of the screen and select the surface(s) to be plotted.
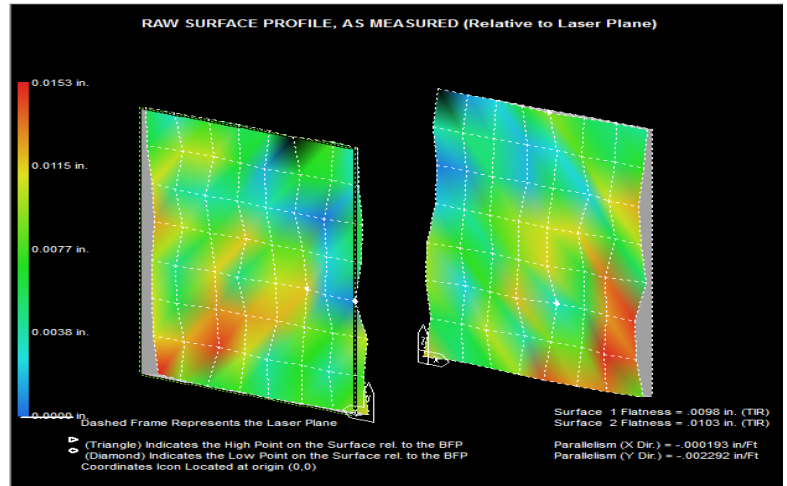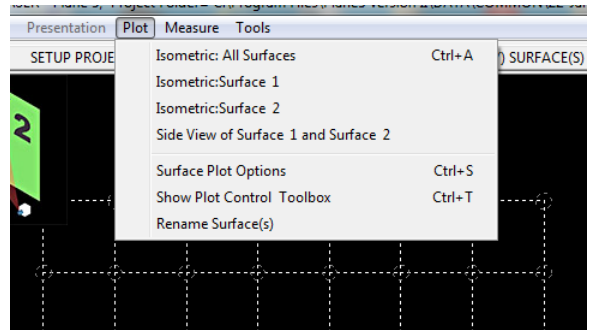
Plotting Data

1. Click **Plot** to display a menu for selecting the surface(s) to be plotted. Each surface can be plotted individually, or all surfaces can be plotted in a single view by selecting *Isometric All Surfaces*. Surface selections can be changed at any time by clicking **Plot** and making a different selection.

2. Click **Surface Plot Options** to define the options to display in the plot.

   - **Show X/Radial Lines** displays the radial lines through a circle when the selected surface is round. The X lines will intersect the Y lines.
   - **Show Y/Circ. Lines** displays the circle lines when a surface is round. The X lines will intersect the Y lines.
     Note: The X Radial Lines and the Y Circle Lines are normally linked so both are viewed. They may be unlinked by unchecking the Linked Box.
   - **Overlay Surface Grid on Shaded Surface Plots** displays a measurement on shaded plots, making it easier to determine measurement points on the plot. This does not apply when shading is disabled.
   - **Show Reference Grid** displays the reference grid under the plot.
   - **Show Z/Elevation Lines** displays elevation lines from the reference grid to the surface plot.

3. Click **Shading Options** to change the graphic resolution for faster drawing. Circles and arcs will not be defined with lower resolution settings. Shading may be disabled, and single or multiple colors may be selected.

   Coordinate System (Hamar Default) places the X-zero and Y-zero coordinates in the upper left hand corner of Surface 1, the lower left corner of Surface 2, and the lower right corner of Surface 3 on the plot screen.
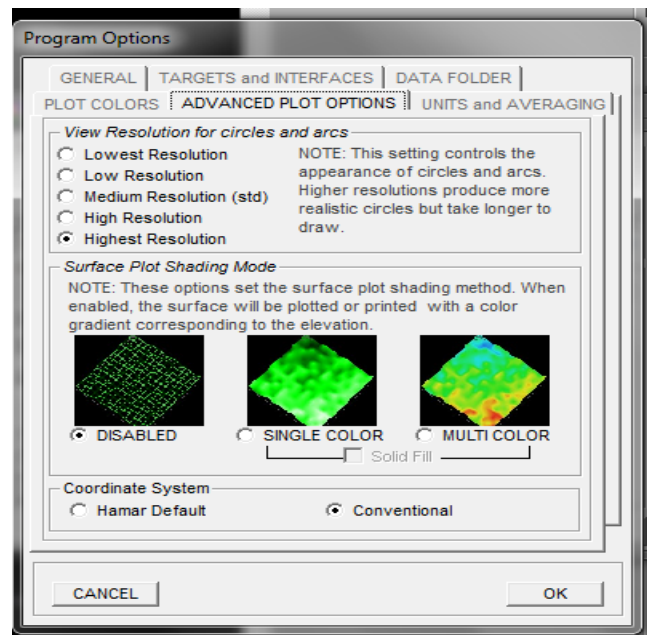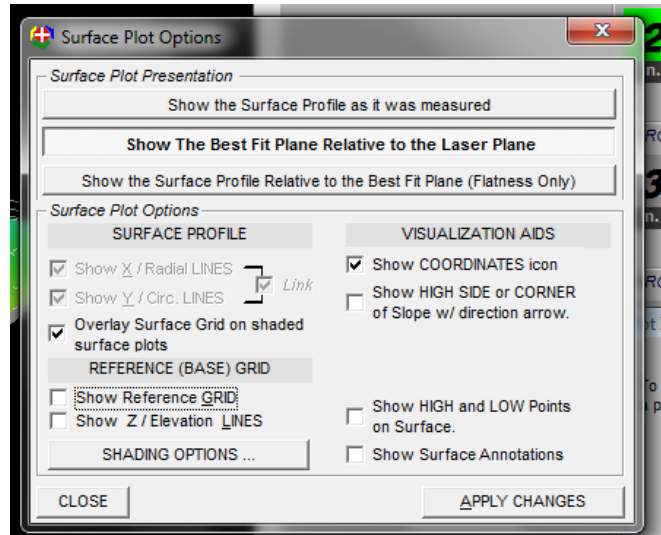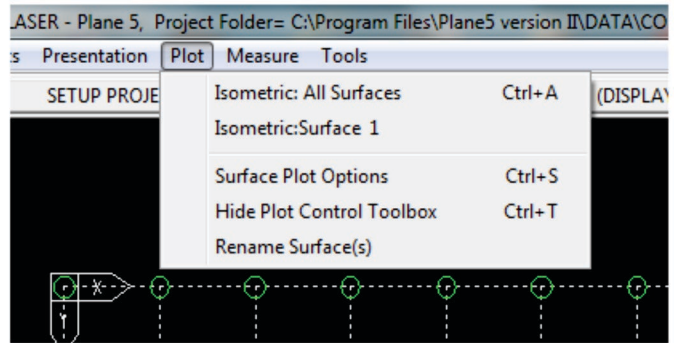
4. **Visualization Aids** contains options for viewing the plots.

- Click **Show Coordinates icon** to turn the X-zero and Y-zero coordinates icon on or off for each plot.
- Click **Show High Side or Corner of Slope w/direction arrow**
- Click **Show HIGH and LOW points on Surface** to activate or deactivate the high and low point icons on the plot.
- Click **Show Surface Annotations** to display the name of the surface on the plot.

Identifying Data for a Measured Point on a Plot

Moving the cursor over a measured point displays the measurement reading for that point on the left side of the screen. In addition, a Plot Information box appears on the right side of the screen identifying the X- Y coordinates of the measured point, the target reading value, the deviation from the Best Fit Plane, the "As Shown" reading and the flatness of the surface.
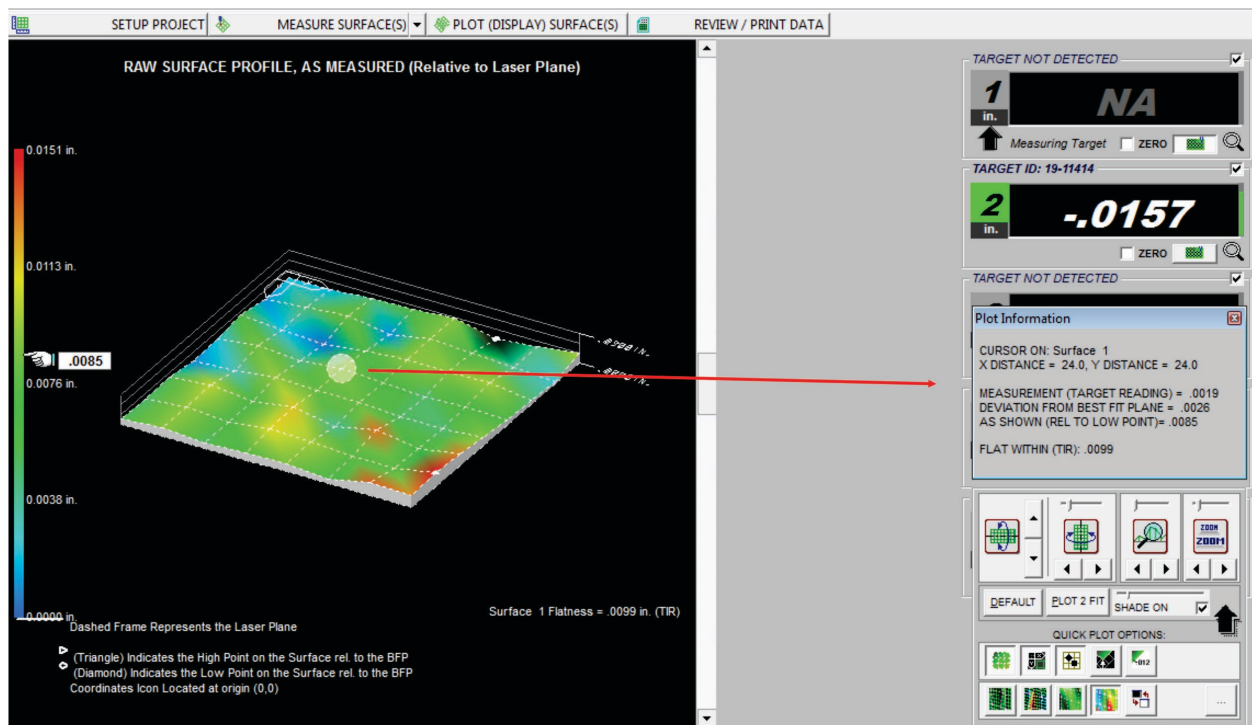
Changing How the Plot is Presented

Click **Presentation** in the Action Bar to list the options for displaying a plot.

- **Surface Profile as Measured (Default presentation)**
  Selecting **Surface Plot as Measured** displays a plot showing the measured points' deviation from the laser plane. If any measured points are a negative number (below the laser plane), the program detects the most negative point and adds that number to all the other measured points. The most negative point then becomes zero, so all measured points are either zero or positive numbers and all points will either be displayed at or above the laser plane.

  When **Review/Print Data** is selected, the Raw Flatness data displays the actual measurement at each location and the **As Configured/Plotted Data** will display as positive numbers since Plane5 adds the most negative number to all of the **Raw Flatness Data** numbers.

- **Best Fit Plane Relative to LASER (SLOPES)**
  Selecting **Best Fit Plane Relative to LASER (SLOPES)** plots the Best-Fit Plane relative to the laser plane. This is a representation of the slope of the Best-Fit Plane relative to the laser plane with no deviation in the surface from point to point. The only deviation will be a slope between the two planes. This is useful when measuring levelness of a surface or measuring the parallelism of one surface to another.

  The **Raw Flatness Data** in the report is the data that was recorded at each measured point and the **As Configured/Plotted Data** column in the report is the corrected data.
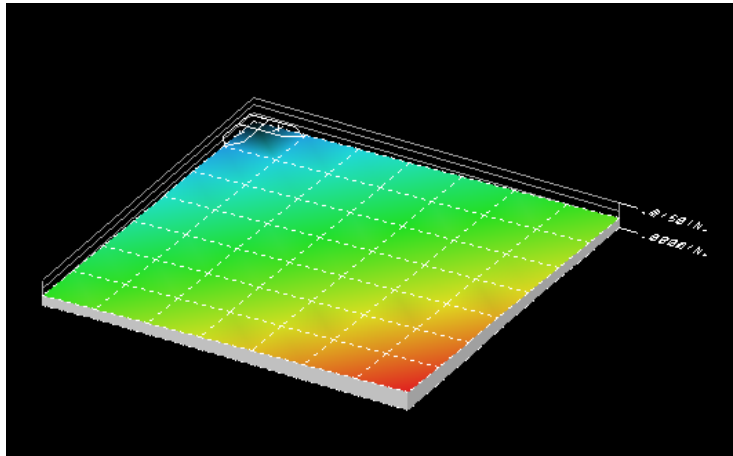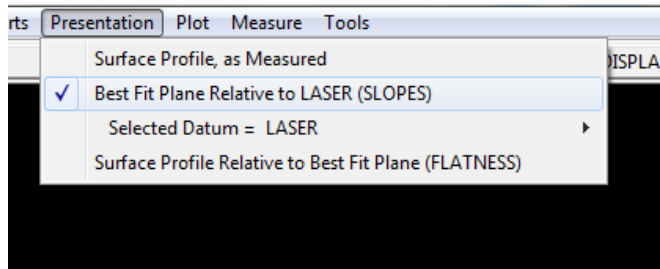
- **Surface Profile Relative to Best Fit Plane (FLATNESS)**
  Selecting **Surface Profile Relative to Best Fit Plane (Flatness)** displays a plot of the true flatness of the measured surface. This plot shows the deviation of each point relative to the best fit plane.
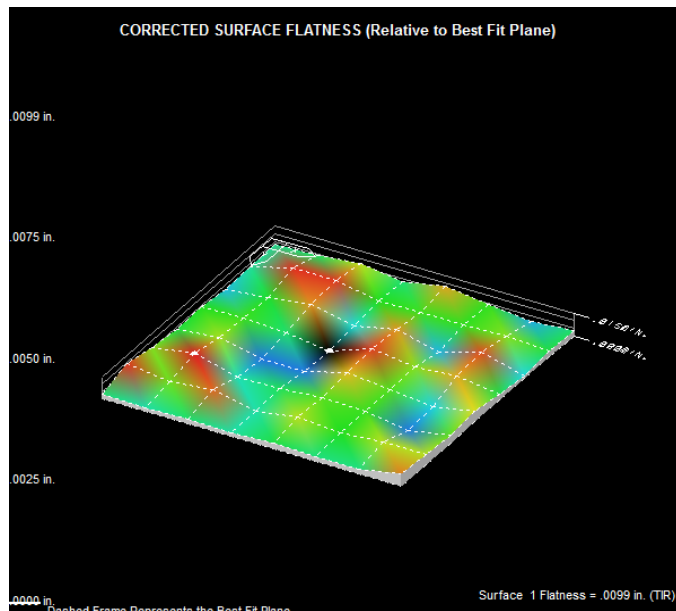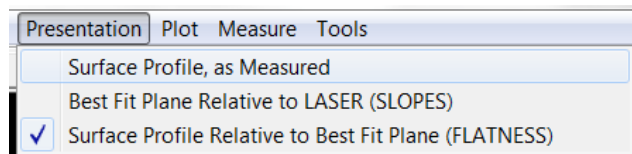
Plot Viewing and Shading Options

Plot Viewing Options
are located in the lower
right corner of the Plot
screen. Click the down
arrow to display the
Quick Plot Options.
Hover the mouse over any
option to determine its
purpose.
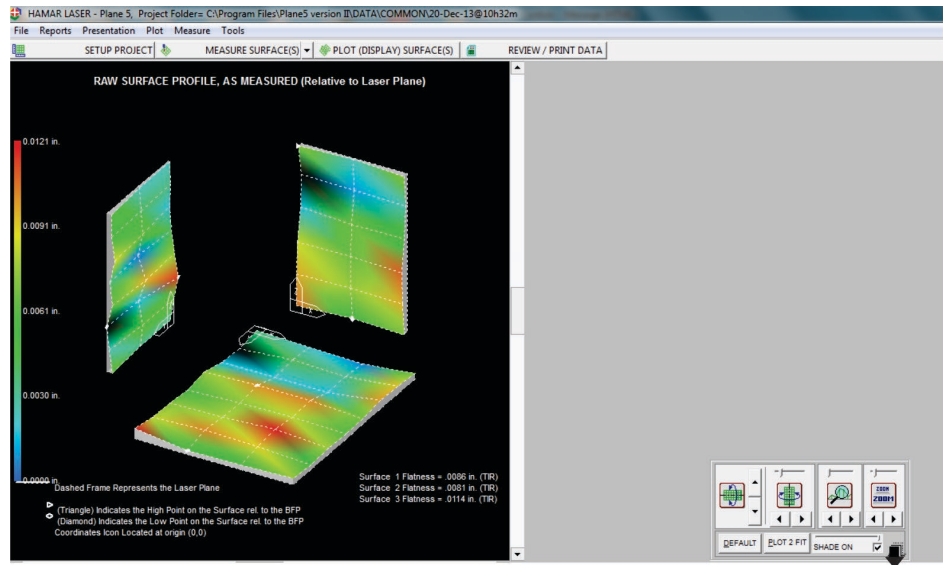
Plot Viewing Options allow the plot view to be
adjusted. The view may be rotated, zoomed in or
out, or the surface distortion may be magnified.
Experiment with the plot view to best illustrate
the alignment relationship.
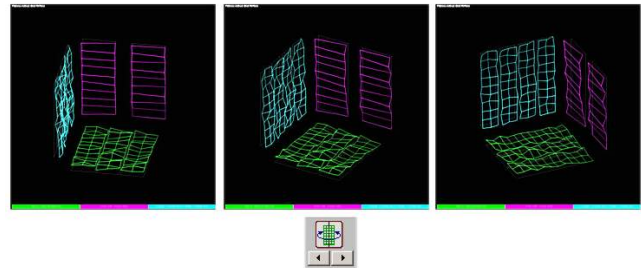
The viewing options are as follows (from left to right):

Pitch – rolls the image vertically.
Yaw – rolls the image clockwise and
counterclockwise.
Magnify – magnifies the image to better
display the high and low points.
Zoom – zooms in or out on the *entire* image.
To *selectively* zoom into an area of any
surface:

1. Hold down the **SHIFT** key.
2. Left-click on the plot around the
   area to zoom.
3. Drag the mouse to draw a box
   around the area.
4. Release the mouse and the SHIFT
   key
5. To restore the full view, click on the DEFAULT or PLOT 2 FIT buttons in the control box.
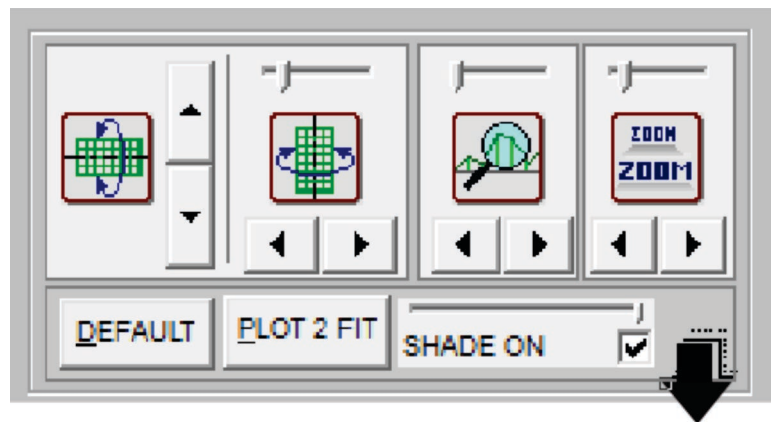
Default – returns the image to the default size if an area has been enlarged.
Plot 2 Fit – resizes an image to fit the screen.
Shade – turns shading on or off when the arrow is used to bring up the Quick Plot Options for shading.
Up/Down Arrow – opens/closes the Quick Plot Options panel for shading options.

Quick Plot Options

The Quick Plot options provide a variety of shading schemes for a plot. The **Shade On** box must be enabled in the **Plot Viewing Options** to perform shading of a plot. To determine the purpose of a Quick Plot Option, hover the mouse cursor over any box to display an explanation. Experiment with these shading options to display the plot in a way that is most satisfactory. Some examples are shown below.
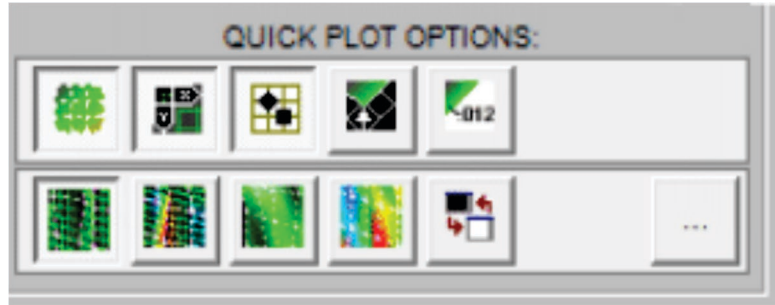
The shading options are as follows (from left to right):

Upper row (Display)
1. Displays/hides the overlay grid
2. Displays/hides the X=0, Y=0 icon
3. Displays/hides the low and high point markers
4. Displays/hides the corner arrow marker
5. Displays/hides annotations

Bottom row (Coloring)
1. Single-color gradient mesh
2. Multi-color gradient mesh
3. Single-color gradient shade
4. Multi-color gradient shade
5. Changes background white or black
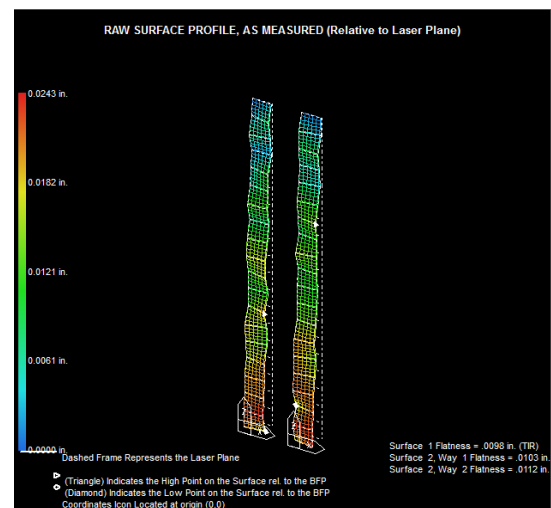
Multi-color gradient mesh
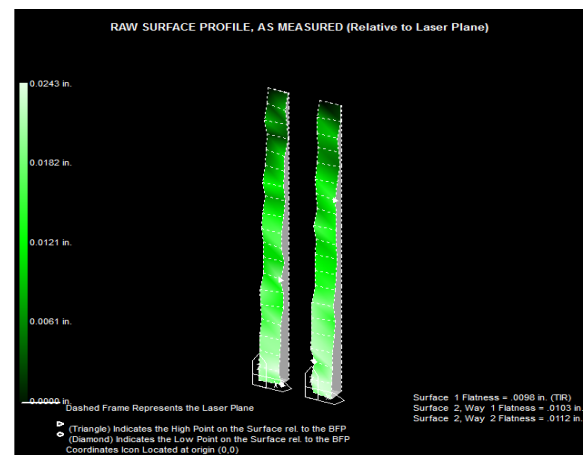
Single-color gradient shade

Reporting Data

When plotting is completed, click **Reports** to save the plot area image and to review/print data.

Review/Print Data is also an option on the **Alignment Steps Button Toolbar**.
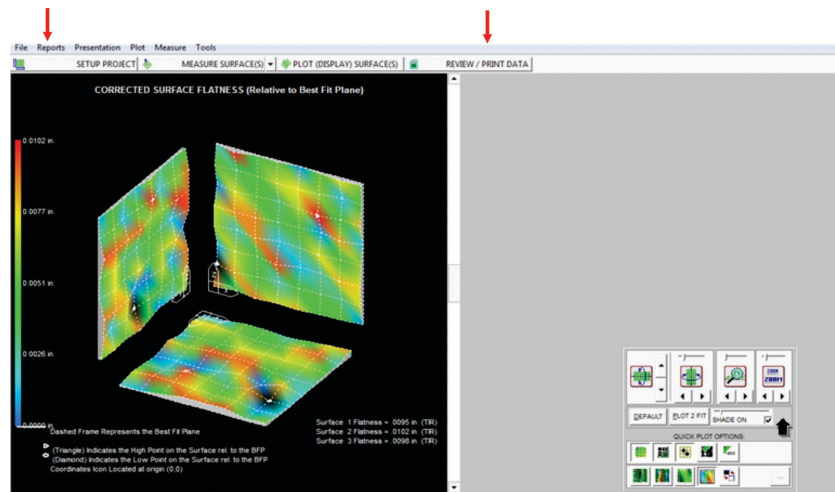
Figure 6 – Reports and Review/Print data shown on the toolbars

Exporting Data

Select **Export Data** to save the data to a user-specified folder. Data is saved in a format suitable for importing into an Excel file. Graphics are not exported.
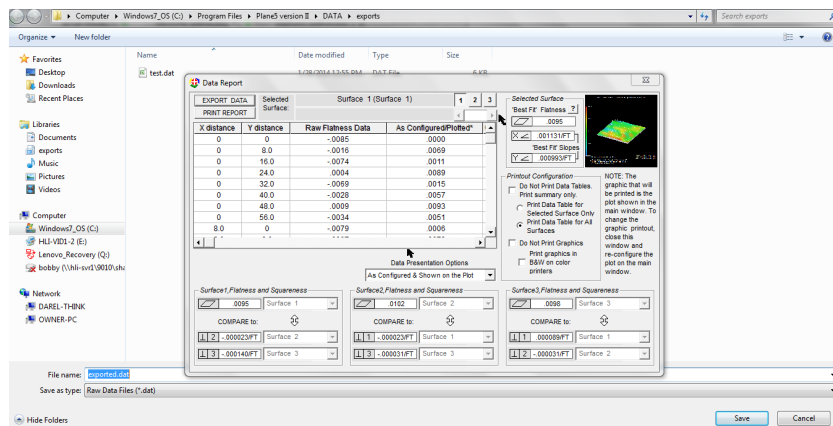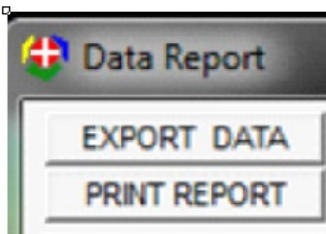
Before printing, a window displays allowing changes to be made to the Printout Header.
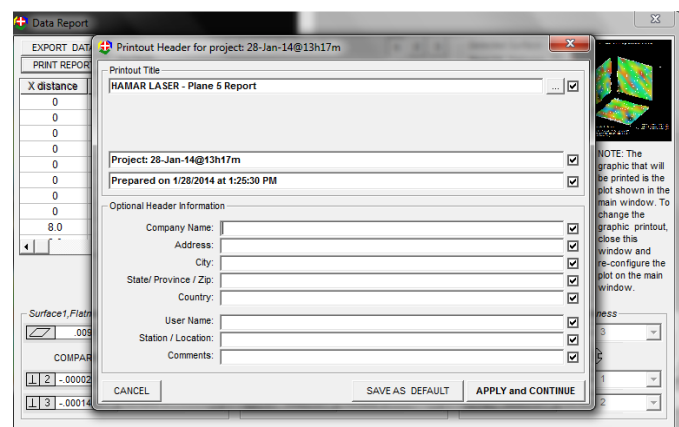
The Data Report Screen

When the **Data Report** screen displays, in addition to the X and Y distances, the **Raw Flatness Data** indicates the measurement taken at each point. The **As Configured/Plotted** data is the deviation of each measured point from the Best-Fit Plane. The program finds the most negative deviation point on the surface and makes this point zero. All other points will be positive numbers.
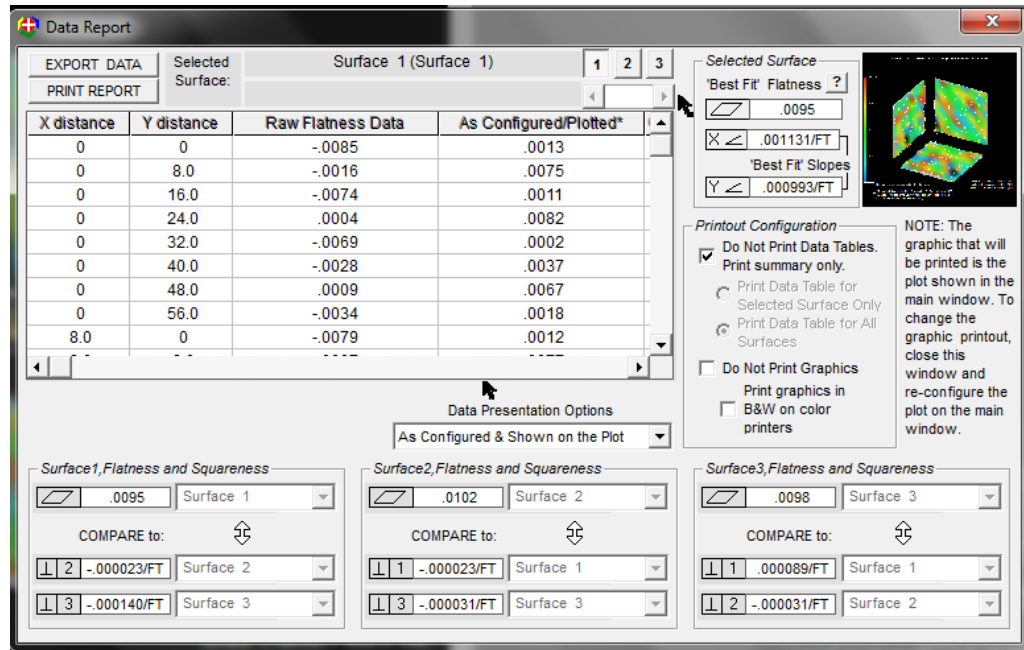
Surface

Select the surface for which to generate data in the table. Use the slider bar to select Surface 1, Surface 2 or Surface 3.
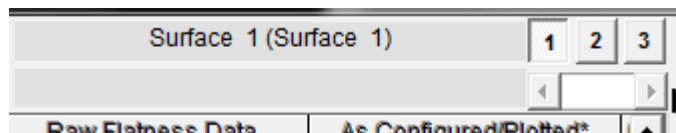
Surface Flatness and Squareness

The **Surface Flatness/Squareness** for each measured surface is displayed at the bottom of the **Data Report** screen. The Flatness data is the true flatness of each surface as calculated with the Least-Squares-Best-Fit Algorithm. **COMPARE to:** shows the Best-Fit Plane squareness of each surface to the Best- Fit Plane of other measured surfaces.
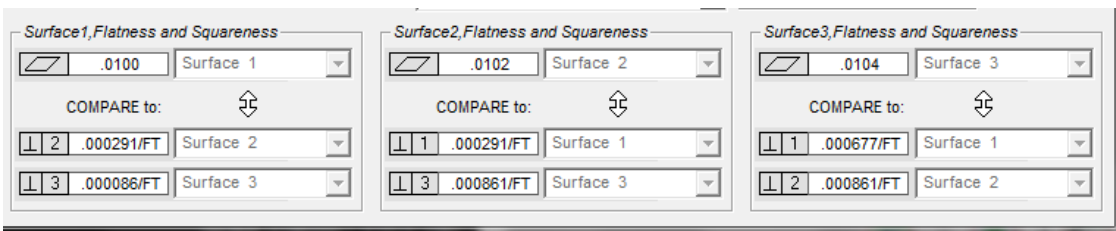
Selected Surface

The **Selected Surface** data displays the true flatness of the selected surface, the slope of the Best-Fit Plane in the X direction and the slope of the Best-Fit Plane in the Y Direction.
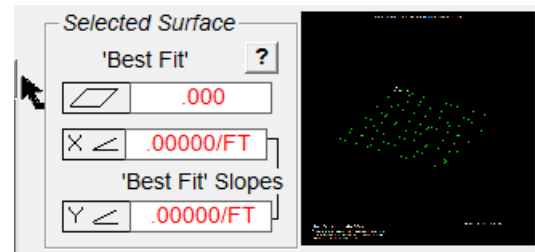
The Plot in the upper right corner is the current plot displayed on the screen. This plot does not change when selecting different surfaces as explained in the note below the plot representation.

NOTE: The graphic that will be printed is the plot shown in the main window. To change the graphic printout, close this window and re-configure the plot on the main window.
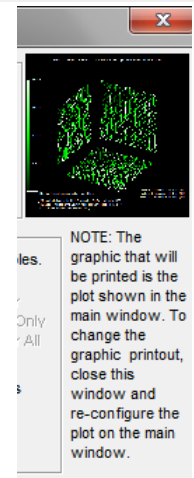
Best-Fit Flatness is the maximum deviation of all the recorded data points from the Best-Fit Plane (the plane that "best fits" the recorded data using the least-squares, best-fit algorithm). It is the true measure of flatness. Click the question mark **(?)** next to **Best Fit** to display an example of Best-Fit Flatness.

Best-Fit Slopes is the deviation in angle of the Best-Fit Plane from the laser plane. This shows how close the reference points used on the surface are to the other points on the surface. For example, if one or two reference points are used that are very far off the rest of the points, the laser plane will be tilted relative to all the other points. These slopes are commonly used when measuring parallelism, as a comparison of the best-fit slopes from one surface to the other is needed.

Best-Fit Slopes can also indicate if the reference points were not bucked in carefully. A large flatness error, as well as a large slope error, could mean that setup was not performed carefully.

Best-Fit Slopes can also indicate how far from earth level the surface is. If the laser is leveled and used as a reference, and then the surface is measured, these slopes will indicate how far out of level the surface is.
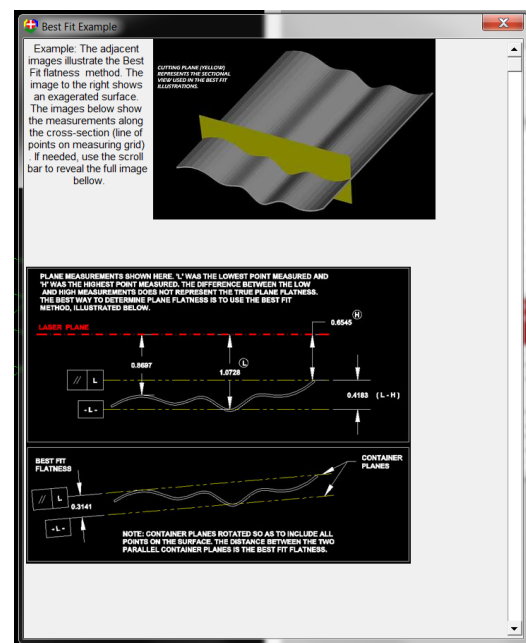
Data Presentation Options

Changing the **Data Presentation Options** from the dropdown menu (shown in Figure 8) also changes the heading for the last column on the right in the Data Report and the data for each point is corrected for the option selected.

Data Presentation Options

As Configured & Shown on the Plot ▼
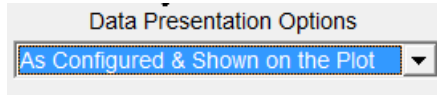
Selecting **As Configured & Shown on the Plot** prints the data and the plot that was displayed on the screen when **REVIEW/PRINT DATA** was selected.

Data Presentation Options

Surface Relative to B.F. Plane(Flatnes ▼

ta	As Configured/Plotted*	
	.0013	
	.0075	
	.0011	
	.0082	
	.0002	
	.0037	
	.0067	
	.0018	
	.0012	

Data Presentation Options

As Configured & Shown on the Plot ▼

Figure 7 – *Data Presentation Options*
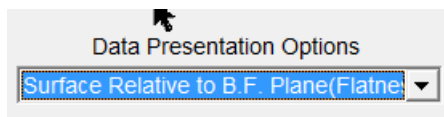
Selecting **Surface Relative to BF Plane (Flatness)** displays the deviation of the measured points from a best-fit plane. This is the true *flatness* of the measured plane.

Data Presentation Options

B.F. Plane Relative to LASER (Slopes ▼
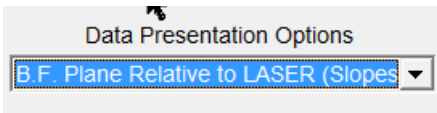
Selecting **BF Plane Relative to LASER (Slopes)** displays the data for a best-fit plane relative to the laser plane. The laser plane and the best fit plane are absolutely flat planes, so this represents the *slope* between the best fit plane and the laser plane. There is no surface deviation.

Printout Configuration

Note: *Only the graph that is plotted will be printed in the report. If additional graphs are needed, separate reports must be printed for each graph.*

Checking **Do Not Print Data Tables. Print summary only** prints only a summary table. If this option is left *unchecked*, a data table for the selected surface only or a data table for all surfaces may be printed.

Enable **Do Not Print Graphics** to prevent graphics from being printed in the report. **Print graphics in B&W on color printers** will print only in black and white if using a color printer.

Plane5 Sample Report

HAMAR LASER - Plane 5 Report

Flatness

Surface 1	.0095 In (TIR)
Surface 2	.0102 In (TIR)
Surface 3	.0098 In (TIR)

Slope of Best Fit Plane relative to Laser Plane

Surface 1 (X Slope)	.001131 In/Ft, 19.4 arc secs.
Surface 1 (Y Slope)	.000993 In/Ft, 17.1 arc secs.
Surface 2 (X Slope)	.000873 In/Ft, 15.0 arc secs.
Surface 2 (Z Slope)	-.001016 In/Ft, -17.5 arc secs.
Surface 3 (Y Slope)	-.000904 In/Ft, -15.5 arc secs.
Surface 3 (Z Slope)	-.001272 In/Ft, -21.9 arc secs.

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

Squareness (Perpendicularity)

'Surface 1' TO 'Surface 2'	-.000023 In/Ft, -0.4 arc secs., Leaning Away from each other
'Surface 1' TO 'Surface 3'	-.000140 In/Ft, -2.4 arc secs., Leaning Away from each other
'Surface 2' TO 'Surface 3'	-.000031 In/Ft, -0.5 arc secs., Leaning Away from each other

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HAMAR LASER - Plane 5 Report

BEST FIT PLANE SLOPE(S)
Datum = Laser Plane

0.0102 in.	
0.0076 in.	
0.0051 in.	
0.0025 in.	
0.0000 in.	

Dashed Frame is the Laser Plane
Coordinates Icon Located at origin (0,0)

Surface 1 Flatness = .0095 in. (TIR)
Surface 2 Flatness = .0102 in. (TIR)
Surface 3 Flatness = .0098 in. (TIR)
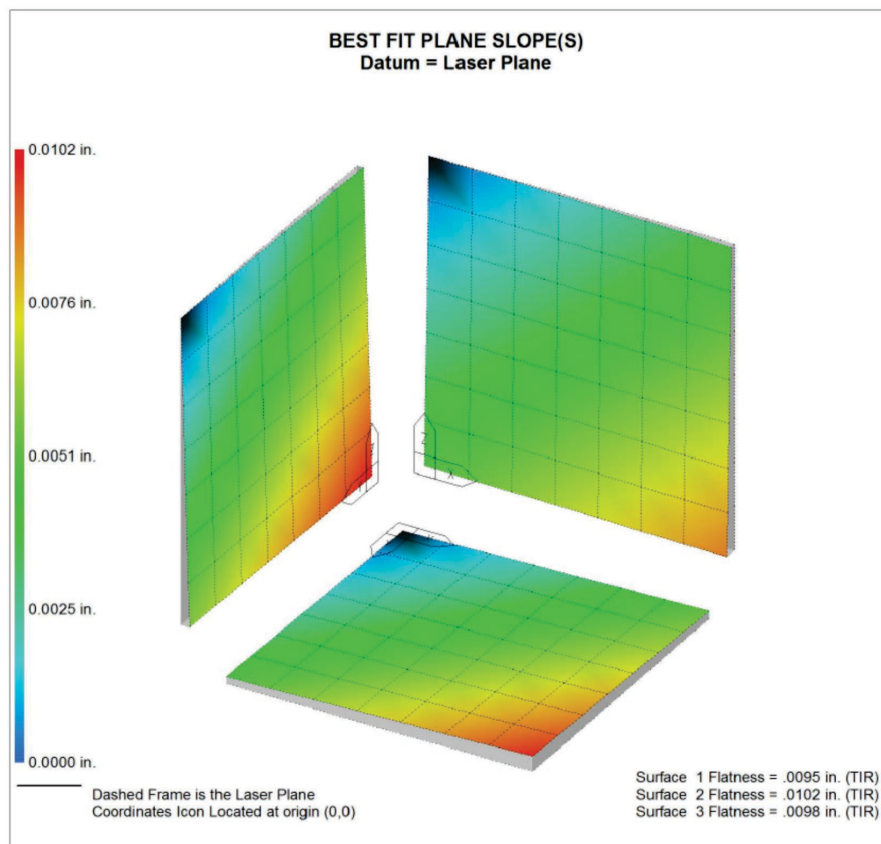
X distance	Y distance	Raw Flatness Data	As Configured/Plotted*	Comments
0	0	-.0085	.0000	
0	8.0	-.0016	.0007	
0	16.0	-.0074	.0013	
0	24.0	.0004	.0020	
0	32.0	-.0069	.0026	
0	40.0	-.0028	.0033	
0	48.0	.0009	.0040	
0	56.0	-.0034	.0046	
8.0	0	-.0079	.0008	
8.0	8.0	-.0007	.0014	
8.0	16.0	-.0025	.0021	
8.0	24.0	-.0012	.0027	
8.0	32.0	-.0052	.0034	
8.0	40.0	-.0034	.0041	
8.0	48.0	.0044	.0047	
8.0	56.0	-.0035	.0054	
16.0	0	-.0033	.0015	
16.0	8.0	-.0016	.0022	
16.0	16.0	-.0026	.0028	
16.0	24.0	.0032	.0035	
16.0	32.0	-.0054	.0042	
16.0	40.0	.0045	.0048	
16.0	48.0	.0044	.0055	
16.0	56.0	.0009	.0061	
24.0	0	-.0038	.0023	
24.0	8.0	-.0022	.0029	
24.0	16.0	.0009	.0036	
24.0	24.0	.0035	.0042	
24.0	32.0	-.0028	.0049	
24.0	40.0	.0017	.0056	
24.0	48.0	.0037	.0062	
24.0	56.0	.0064	.0069	
32.0	0	-.0045	.0030	
32.0	8.0	-.0020	.0037	
32.0	16.0	.0013	.0043	
32.0	24.0	.0044	.0050	
32.0	32.0	.0037	.0057	
32.0	40.0	-.0003	.0063	
32.0	48.0	.0026	.0070	
32.0	56.0	.0068	.0077	
40.0	0	-.0017	.0038	
40.0	8.0	.0029	.0044	
40.0	16.0	.0022	.0051	
40.0	24.0	.0001	.0058	
40.0	32.0	-.0032	.0064	
40.0	40.0	.0058	.0071	
40.0	48.0	.0042	.0077	
40.0	56.0	.0080	.0084	
48.0	0	.0023	.0045	
48.0	8.0	.0046	.0052	
48.0	16.0	.0025	.0058	
48.0	24.0	-.0008	.0065	
48.0	32.0	.0054	.0072	
48.0	40.0	-.0020	.0078	
48.0	48.0	-.0007	.0085	
48.0	56.0	.0027	.0092	

(table continued on next page)

Notes:
'As Configured/Plotted' = User Customized Data, as shown on the Surface Plot
'Raw Flatness Data' = Target measurements, as recorded
*Surface Data Shifted Up. Low Point=0, all other points Positive

X distance	Y distance	Raw Flatness Data	As Configured/Plotted*	Comments
56.0	0	.0039	.0053	
56.0	8.0	-.0016	.0059	
56.0	16.0	.0010	.0066	
56.0	24.0	.0000	.0073	
56.0	32.0	-.0002	.0079	
56.0	40.0	.0004	.0086	
56.0	48.0	.0013	.0093	
56.0	56.0	.0057	.0099	

Notes:
'As Configured/Plotted' = User Customized Data, as shown on the Surface Plot
'Raw Flatness Data' = Target measurements, as recorded
*Surface Data Shifted Up. Low Point=0, all other points Positive

Appendix A – Using the Zigbee® Radio Utility

Pre-installing the Common USB Port Driver (A-910-2.4ZB)

This driver is required for the A-910-2.4ZB Transceiver and to communicate with targets via the computer's USB port. The driver creates a virtual COM Port that is recognized by the applications as a standard serial port.

Note: You must pre-install this driver prior to connecting the device(s) to the computer through the USB port.

Installing the Driver

1. Insert the A-910-2.4ZB Radio Programmer CD in the CD ROM drive.
2. Select **My Computer**, locate the CD ROM icon and click to open it.
3. Select the USB Drivers folder.
4. Select the correct Operating System installed on your computer (Windows 2000, Windows XP, etc.) and open the folder.
5. Locate the **CP210x_VCP** icon and click to initiate the installation process. The **Install Driver** dialog box displays.
6. Click **Browse** to select an installation folder different from the default folder (optional).
7. Click **Install** to continue. Once the installation is complete, the **Installation Successful** message displays (see Figure 8).
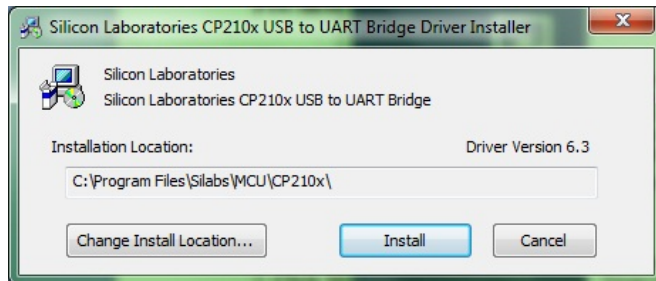
Figure 8 - *USB Common Driver Install*

Installing the A-910 Utility Software

1. Insert the A-910-2.4ZB Radio Programmer CD in the CD ROM drive.
2. Select **My Computer**, locate the CD ROM icon and click to open it.
3. Locate the **Setup** icon and click to initiate the installation process. Click **NEXT** to continue.
4. Click **Browse** to select an installation folder different from the default folder (optional).
5. Click **Next** to continue. Once the installation is complete, the **Installation Complete** message displays. Select **Close.**

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Configuring the Hardware and Utility Settings

1. Insert the A-910 ZB dongle into any unused USB Port (see Figure 9). The computer should automatically assign a COM port number to the dongle.

2. Start the A-910 Utility Software. The software should display the COM port assigned to the Zigbee Dongle (see Figure 10). If the utility does not automatically detect the COM port, it must be manually selected (see **Manually Selecting a COM Port** on Page 37).

Figure 9 – *A-910 Zigbee Dongle*

3. The Target System ID or R-1307 CH (channel) is the number associated with the A-1519/1520 targets or R-1307 Readout. If using both the A-1519/1520 targets and an R-1307 Readout, both need to be set to the same system ID and channel (see Figure 11).
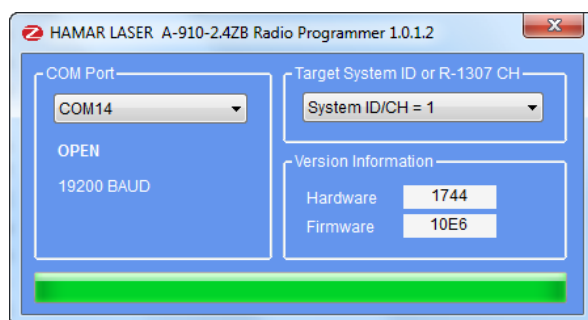

Figure 10 – *A-910 Utility showing the COM Port, System ID and Channel settings*
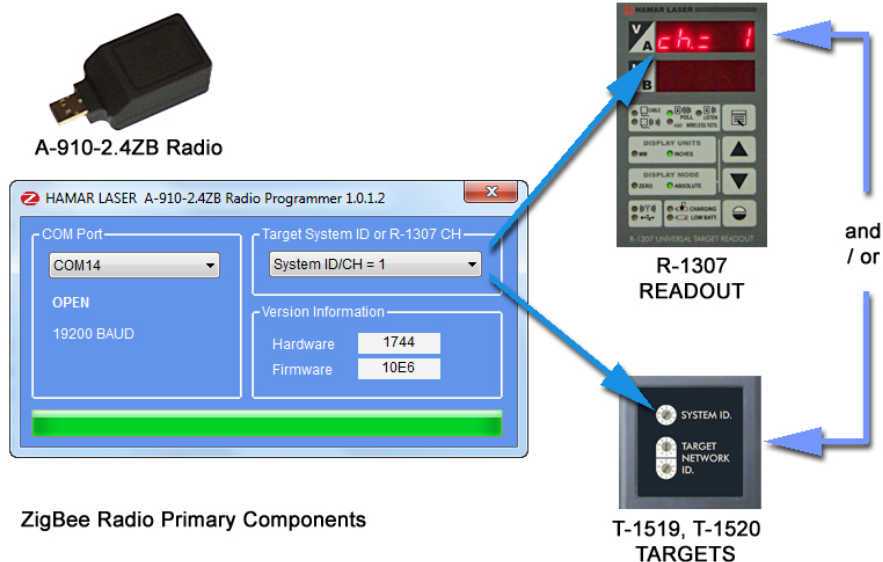
Figure 11 – *System ID Setup*

Manually Selecting the COM Port

The A-910 Utility should automatically detect the COM Port upon startup. If not, use the following steps to locate the correct COM Port.

Windows XP

1. Right-click My Computer.
2. Click **Properties** and then select the **Hardware** tab.
3. Click **Device Manager**.

Windows 7

1. Click the **Start** button and select **Control Panel**.
2. Click the **System** icon.
3. In the **System** window, click on the Device Manager link located under the **System** heading.
4. In Device Manager, scroll down to **Ports.** Expand the listings under **Ports** to reveal all the ports installed.
5. Locate **SILICON LABS CP210x USB to UART Bridge (COM x)** (see Figure 12**).**
6. Note the COM Port listed and select that COM Port in the A-910 Zigbee Utility software using the drop-down arrow (see Figure 10).
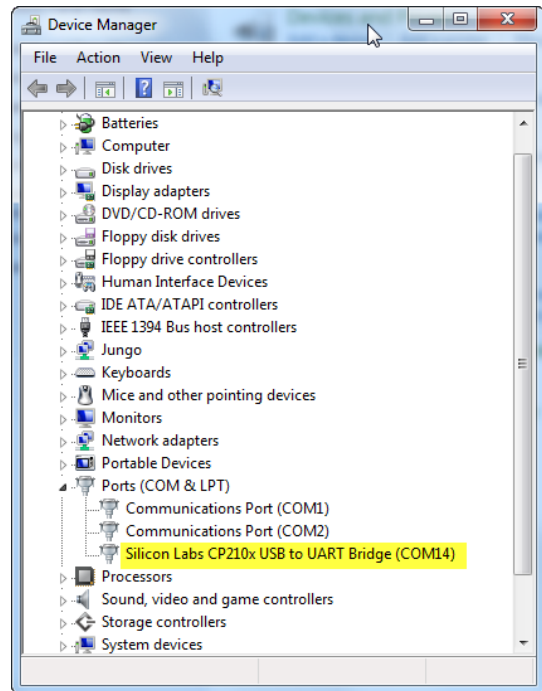
Figure 12 – *Device Manager showing COM Port for A-910 Dongle*

Setting the Target System ID and Target Network ID

The System ID is a Radio Network Address that is used by the Radio Communications Protocol to filter unwanted data from other radio transceivers and targets using a different address. Only targets and radio transceivers that are set to a matching System ID can communicate with each other.

Because no two targets with the same System ID can transmit simultaneously, it is necessary for each target to be programmed to respond only when it is being addressed. The Target Network ID is the target address on the communications network. Under Host (computer) control, the radio transceiver transmits a message called a *polling request* that contains the Target Network ID of one specific target. All targets receive all polling requests, but only the target with a Network ID matching the ID contained in the polling message will reply (Transmit Data to the Host).

There are three rotary DIP switches located on the right side of the target, shown in Figure 13:

- The uppermost switch sets the System ID.
- The two lower switches are used to set the target network ID.

Setting the System ID

Note: Before selecting a System ID, ensure that it is not already in use by another system within the radio coverage area.

Using a small screwdriver, rotate Switch 1 to align the arrowhead with the System ID number (0-9). Figure 13 shows the System ID switch set to 1.

Figure 13 – *Unitarget ID Switch set to 1*

Setting the Target Network ID and System ID for the R-1307 Readout

To make the unit visible to all other radio-enabled devices, you must set the Target Network ID and the System ID for the readout.

1. **Set the Local Readout/Target Network ID**
   Press the **MENU** button until the *upper* display shows ιd=ηη (nn is also equal to the R-1307 number) and the matching target number with the current target ID (ηη) blinking. Use the UP and DOWN arrow keys to set the Target ID.

   Press the **MENU** button again until the lower display shows ιd=ηη, with the current target ID (ηη) blinking. Use the UP and DOWN arrow keys to set the Target ID to the same value as that of the upper display's Target ID.

2. **Set the System ID (Radio Channel)**
   Press the **MENU** button until the upper display shows ch = ηη, with the current System ID (ηη) blinking. Use the UP and DOWN arrow keys to set the System ID.
   Note that **nn** must be set to the same number as the channel switch setting of the A-910 radio transceiver (see Figure 14).
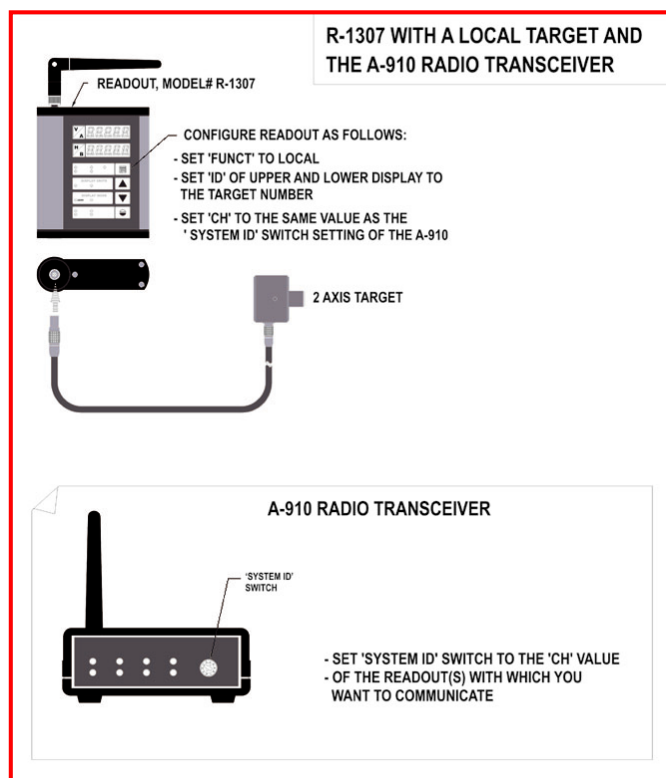

Figure 14– *R-1307 with Cabled (Local) Target and A-910 Radio Transceiver*

Miscellaneous Display Messages

-HLI-

rι_00   Startup Message. Lower Display shows firmware Revision Number.

...   3 moving dots. Wireless target is not responding to a polling request from Readout. Check ID and Channel settings. Check Target(s).

- - -   3 dashes. Target detected but the laser is not on target. Check laser.

ch_=no

rAdιο   Radio channel cannot be selected because no Radio is present or detected.
             Standard message for R-1307C. For Models R-1307 or R-1307W, this message indicates a fault in the radio module.

FAuLt

PSd   Indicates a problem with the connection to the Cabled (Local) Target's Position Sensing Device (PSD). Check plugs and cable(s).

tGt_η

UncAL   Target 'η' descriptor does not contain target calibration data.