

FARO Scanning Plugin

for Geomagic Studio 6 service release 4, Geomagic Qualify 6 service release 2,
and Geomagic Qualify 7

Document version B

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The FARO scanner is a seven-axis measurement device from FARO Technologies, Inc. that offers full scanning or select data-gathering without the user having to interchange parts. **Plugins > Faro Scanning** is an interface to the FARO scanner. The purpose of this plug-in is to integrate data capture and processing activities into a single user interface. Specifically, the Faro Scanning function in Geomagic products allows data capture and storage to the model manager in a single step, and the creation of datums and features on the scanned object.

(This menu item in Geomagic products is an optional, separately licensed feature. If Faro Scan does not already appear on the Plugins menu, download the software from support.geomagic.com/downloads, install it according to simple instructions on the web site, and re-start this procedure.)

Turn on the FARO scanner *before* selecting **Plug-ins > Faro Scanning**.



In This Document:

- For reference information on the controls and indicators of the FARO Scanning plug-in, see [Controls and Indicators](#) on 1-2.
- Immediately after activating the Faro Scanning plugin, a popup might prompt you to “reference the encoders”. See [Referencing the Encoders](#) on 1-6.
- From time to time, especially after moving the scanner to a new location, you will calibrate the hard and laser probes. See [Calibrating the Hard and Laser Probes](#) on 1-6.
- Reverse engineering with Faro Scanning and **Geomagic Studio** - see [FARO Scan -- Step-by-Step](#) on 1-12.
- Datum and feature creation with Faro Scanning and **Geomagic Studio** or **Geomagic Qualify** - see [Datum and Feature Creation -- Step-by-Step](#) on 1-13.
- Computer-aided inspection with Faro Scanning and **Geomagic Qualify** - see [Faro Scanning with Geomagic Qualify](#) on 1-17.

Controls and Indicators

This section details the controls and indicators on the user interface of the FARO Scanning plug-in.

-  **Alignment** icon button - activates controls and indicators for the alignment process. Every scan must be performed with respect to a known spatial orientation (also called a “coordinate system”, also incorrectly called an “alignment”). The spatial orientation remains in effect on subsequent scans and the next time Geomagic Studio or Qualify is started. Define an orientation by one of the following four methods.
 - **Select Probe** group -
 - **Probe** button - presents a popup window in which you specify the physical probe that is attached to the FARO arm. In the Select Probe window, identify the currently installed hard probe (such as **3mm Ball Probe**). Optionally, perform calibration of that probe. Click **OK**.
 - **3-2-1 Alignment** button - Allows the user to establish spatial orientation by defining the position of the X, Y, and Z planes. See [3-2-1 Alignment](#) on 1-10.
 - **Last Test Model Alignment** button (selectable only when an object has been designated as the test object, or when a Feature/Datum object is present in the model manager) - specifies that the spatial orientation be based on the scheme of an existing object. In Geomagic **Qualify**, use the orientation of the currently designated test object. If no test object exists, use the spatial orientation of the Feature/Datum object. If this is Geomagic **Studio**, use the spatial orientation of the Feature/Datum object.
 - **Merge Features/Datums to Next Scan** checkbox (functional only when a Feature/Datum object exists) - causes the features and datums that exist in the Feature/Datum object to be replicated into the object created during the next scan.
 - **Load Transform** - allows the user to select a .tfm or .xal file that defines a spatial orientation.
 - **Use Arm CSYS** - sets the spatial orientation (also called Coordinate SYSTEM) to the arm default, where the arm base is the origin.

-  **Laser** icon button - activates controls and indicators for the laser scanner.
 - **Object Name** field and **Reset** button - indicates the name of the object that will be stored in the Geomagic model manager. **Reset** does something.
 - **Laser Scanning** group -
 -  **Calibrate Scanner:** Click this if calibration is required for the hard probe and laser probe, or just the laser probe. In response to the prompt, press a radio button to specify the extent of calibration that is required.
 - **Hard Probe Sphere Calibration** - Neither the hard probe nor the laser scanner have been calibrated. Press this button to be taken to the beginning of the hard probe calibration process, then to the laser scanner calibration process.
 - **Measure Sphere With Current Hard Probe** - The hard probe has been calibrated, but it is now clamped to the table in a different position with respect to the base of the arm. Press this button to be taken to the positioning part of the hard probe calibration process, then to the laser scanner calibration process. This is the same as selecting **Alignment | Probe button | Sphere Calibration** or **Hard Probe | Probe button | Sphere Calibration**.
 - **Use Previous Values** - The hard probe has been calibrated and it is still clamped to the table in the same position with respect to the base of the arm. Press this button to be taken to the laser scanner calibration process.
 -  **Scanner Options:** Brings up the Faro dialog that allows specific adjustment of the laser scanner operations.
 -  **Start Scan** button - puts the scanner and software into data collection mode. To return to the application, press the **red** button on the scanner. To actually begin scanning, press the **green** button. To pause, press the **green** button again.
 - **Units** - specifies the units of measure on the object that will be scanned, such as inches or millimeters.

- **Scanning Options** - control the operation of the scanner and the display of data.
 - **Shade Points** checkbox - By the time a scan is stored in the model manager, the plugin will have calculated individual point normals based on the scanner direction at time of acquisition. This checkbox specifies whether to perform these calculations during pauses (in which case you must wait for a calculation to complete before resuming a scan) or after you press OK to store the object in the model manager (in which case you might have to wait for a relatively long time).
 - **Virtual Camera** checkbox - toggles the Virtual Camera functionality of the laser scanner.
 - **Highlight Scan Pass** checkbox - toggles scan pass hi-lighting. When selected, the incoming scan data will appear red, otherwise the incoming scan data will match the light green of previously created scan passes.
 - **Display Polygons** checkbox - toggles the display between Polygons and Points. Acts on all scan passes in the current plugin instance.
 - **Edge Ratio** slider (five settings from Low to High) - specifies the propensity of the software to leave gaps between scan lines in the scan image if you are scanning too fast. [A triangle with *high edge ratio* is one that has two relatively long sides caused by rapid scanning, and a relatively short side which is influenced by the scan line density setting on the FARO Scanner Settings dialog.]
 - When density of scan is more important, such as in a reverse engineering scenario, use a lower Edge Ratio. If you scan too fast, gaps will appear on the scan image. In that case, slow down or make a second pass.
 - When density of scan is less important, such as some inspection scenarios, use a higher Edge Ratio. If you scan relatively fast and scan lines are far apart, software will triangulate the space between scan lines and thereby suggest that the scan is "good". If you are still scanning too fast and gaps appear, slow down or make a second pass.

- **Data Options** - affect the appearance of collected data *after* the plugin is closed.
 - **Merge Scan Passes** checkbox - specifies whether to perform a point merge on all individual scan passes created during the current session of the plugin. The result will be one point object in the model manager.
 - **Sampling** checkbox - specifies whether to perform uniform sampling (a reduction of point density) on the resulting point cloud at the end of a scan pass.
 - **Spacing** - specifies the spacing parameter used by the Uniform Sample operation.
 - **Smoothing** slider (None, Min, Med, and Max) - specifies whether to perform a smoothing operation on each scan line as it is received from the scanner. The intent is that noisy data can be smoothed in real-time to provide better wrapping results. The values are: None, Min, Med, Max.
 - **Filter Angle** field (0 to 90 degrees) - offers the ability to ignore points collected by the scanner beyond the specified angle. This results in much cleaner data. The filter angle can be adjusted between 0.0 and 90.0 degrees. This operation, like smoothing, is on a per scan line basis.

-  **Hard Probe** icon button - activates controls and indicators for the touch probe on the scanner's nose.
 - **Object Name** field and **Reset** button - indicates the name of the object that will be stored in the Geomagic model manager. **Reset** does something.
 - **Select Probe** group -
 - **Probe** button - presents a popup window in which you specify the physical probe that is attached to the FARO arm. In the Select Probe window, identify the currently installed hard probe (such as **3mm Ball Probe**). Optionally, perform calibration of that probe. Click **OK**.
 - **Datum/Feature Type** group - specifies the kind of datum or feature that will be defined by use of the hard probe. A datum or feature can be defined even if no scan data exists yet. If no scan data yet exists, an "empty" point object called Datums/Features is created in the model manager and the new datum and feature sub-objects are stored under it.
 - **Method Input** group - specifies the kind of datum or feature that will be defined by use of the hard probe. A datum or feature can be defined even if no scan data exists yet. If no scan data yet exists, an "empty" point object called Datums/Features is created in the model manager and the new datum and feature sub-objects are stored under it.

- **Show Instructions** checkbox - specifies whether the user interface presents a sentence explaining how to define the datum or feature given the Datum/Feature Type and the Method Input that is chosen.
- **Instructions** (if requested by the Show Instructions checkbox) - presents a sentence explaining how to define the datum or feature given the Datum/Feature Type and the Method Input that is chosen.

Referencing the Encoders

If a graphical representation of the FARO arm pops up, you must now “reference the encoders”. Exercise the arm in every direction until the red arrows on the graphical display disappear.

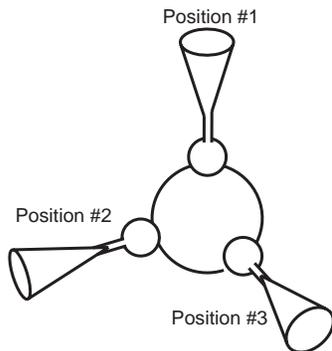
Calibrating the Hard and Laser Probes

From time to time, especially after moving the scanner to a new location, you will calibrate the hard and laser probes.

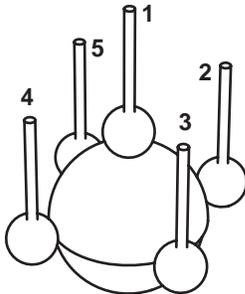
1.   Press the large Laser Scanning icon, then the Calibrate Scanner icon.
2. Before calibrating the laser scanner, the hard probe must be calibrated (or must have been calibrated already). In response to the prompt, select one of the following radio buttons based on the “condition” of the hard probe.
 - **Hard Probe Sphere Calibration** - Neither the hard probe nor the laser scanner have been calibrated. Press this button to be taken to the beginning of the hard probe calibration process, then to the laser scanner calibration process. Go to Step 3.
 - **Measure Sphere With Current Hard Probe** - The hard probe has been calibrated, but it is now clamped to the table in a different position with respect to the base of the arm. Press this button to be taken to the positioning part of the hard probe calibration process, then to the laser scanner calibration process. (This is the same as selecting **Alignment | Probe button | Sphere Calibration** or **Hard Probe | Probe button | Sphere Calibration.**) Go to Step 5.
 - **Use Previous Values** - The hard probe has been calibrated and it is still clamped to the table in the same position with respect to the base of the arm. Press this button to be taken to the laser scanner calibration process. Go to Step 8.

3. In the **Current Probe** pulldown, identify the currently installed hard probe, such as **3mm Ball Probe**, then click **OK**.
4. *If* a graphical representation of the FARO arm pops up, you must now reference the encoders. Exercise the arm in every direction until the red arrows on the graphical display disappear.

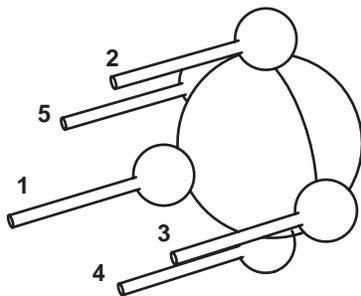
The next three steps refer to Position #1, #2, and #3 as indicated in the following diagram.



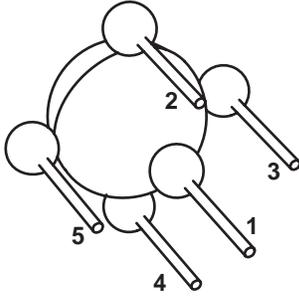
5. In the order indicated by the on-screen illustration, digitize five points around the top of the sphere in probe position number 1.



6. In the order indicated by the on-screen illustration, digitize five points around the front of the sphere in probe position number 2.



7. In the order indicated by the on-screen illustration, digitize five points around the side of the sphere in probe position number 3.

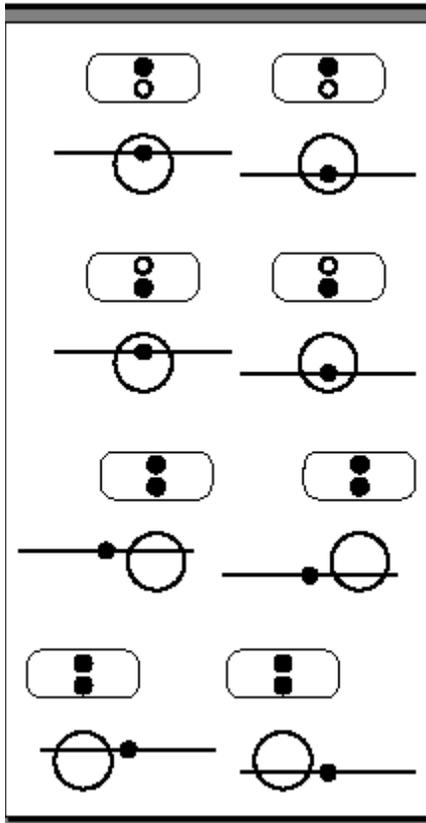


After five points are digitized on each of three angles, an internal calibration process begins.

- If the probe passes the test, the **Calibration Status** is set to Passed and the current date and time appear in the time indicator. Click **OK**. Calibration of the standard (hard) probe is complete.
 - If the probe fails the test, the **Calibration Status** is set to Failed. Click **Retry** and go to Step 5.
8. To calibrate the laser probe, you will digitize eight points from *each* of the three positions, starting with the top view (position 1), a side view (position 2), then the front view (position 3).

Use the on-screen range finder or the two LEDs on the back of the scanner to judge the definition of **Near** range and **Far** range. Starting at position 1, digitize two points in the **Near** range with the **center** of the laser -- one point on the upper half of the calibration sphere and one point on the lower half. The Near range is indicated by the upper green LED on the range finder. The Center range is indicated by both green LEDs on the

range finder. The Far range is indicated by the lower green LED on the range finder.



9. Digitize two points in the **Far** range with the **center** of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
10. Digitize two points in the **Center** range with the **left** side of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
11. Digitize two points in the **Center** range with the **right** side of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
12. Move to position two, which is the left or right side of the sphere.
13. Digitize two points in the **Near** range with the **center** of the laser
14. Digitize two points in the **Far** range with the **center** of the laser
15. Digitize two points in the **Center** range with the **left** side of the laser
16. Digitize two points in the **Center** range with the **right** side of the laser
17. Move to position three, which is the front side of the sphere.
18. Digitize two points in the **Near** range with the **center** of the laser
19. Digitize two points in the **Far** range with the **center** of the laser
20. Digitize two points in the **Center** range with the **left** side of the laser

21. Digitize two points in the **Center** range with the **right** side of the laser After eight points are digitized in each of three positions, an internal calibration process begins.
- If the probe passes the test, the **Calibration Status** is set to Passed and the current date and time appear in the time indicator. Click **OK**. For details on the calibration of both the hard and laser probes, click **View Log** and see the FaroArm USB manual for details. Calibration of the laser probe is complete.
 - If the probe fails the test, the **Calibration Status** is set to Failed. Click **Retry** and go to Step 8.

3-2-1 Alignment

This is a sub-procedure referenced by the Alignment section under [Controls and Indicators](#) on 1-2.

This describes "3-2-1 Alignment" -- how to specify an object's coordinate system by defining the position of three orthogonal planes. The origin of the object's coordinate system will be the point of intersection of the three planes.

1. Click the large  Alignment icon, then the  3-2-1 Alignment icon.

Recall that:

The plane orthogonal to the X axis is the YZ plane.

The plane orthogonal to the Y axis is the XZ plane.

The plane orthogonal to the Z axis is the XY plane.

The *letter* on each of the following icons represents the axis to which a plane is orthogonal. The *sign* on each icon represents a *side* of the plane.



2. If the purpose of this alignment is to synchronize the coordinates a test part with a CAD object, look at the CAD object and ascertain the position of the X , Y , and Z axes (the YZ , XZ , and XY planes) with respect to the CAD object. (Note that a CAD object's coordinate system always uses the right-hand rule).

3. Based on information ascertained in the previous step, perform *any two* of the following three actions:
 - Click the **+X** icon *or* the **-X** icon.
(+X means that "above" YZ is the positive side of YZ.
-X means that "above" YZ is the negative side of YZ.)
 - Click the **+Y** icon *or* the **-Y** icon.
(+Y means that "above" XZ is the positive side of XZ.
-Y means that "above" XZ is the negative side of XZ.)
 - Click the **+Z** icon *or* the **-Z** icon.
(+Z means that "above" XY is the positive side of XY.
-Z means that "above" XY is the negative side of XY.)

The first button you press is designated as **Plane 1**.

The second button you press is designated as **Plane 2**.

Adhering to the right-hand rule, the software automatically selects a third button (either the + or - variant of the plane you didn't pick), and designates it as **Plane 3**. The sign that the software picks is always the sign of **Plane 1** times the sign of **Plane 2**. (+ * + = +) ; (+ * - = -) ; (- * - = +)

4. On the physical object, position the hard probe on a point that lies in **Plane 1**, then click the **green** button on the scanner. Position the probe on a second point that lies in **Plane 1**, then click the **green** button on the scanner. Position the probe on a third point that lies in **Plane 1**, then click the **green** button on the scanner.

You have just defined the position of **Plane 1**.

5. Pull the probe out and away from **Plane 1**, then click the **red** button on the scanner.

If **Plane 1** was designated in Step 3 by a + icon, you have established the + side of **Plane 1**.

If **Plane 1** was designated in Step 3 by a - icon, you have established the - side of **Plane 1**.

6. On the physical object, position the hard probe on a point that lies in **Plane 2**, then click the **green** button on the scanner. Position the probe on a second point that lies in **Plane 2**, then click the **green** button on the scanner. There is no need to select a third point on **Plane 2**.

You have just defined the position of **Plane 2**.

7. Pull the probe out and away from **Plane 2**, then click the **red** button on the scanner.

If **Plane 2** was designated in Step 3 by a + icon, you have established the + side of **Plane 2**.

If **Plane 2** was designated in Step 3 by a - icon, you have established the - side of **Plane 2**.

8. On the physical object, position the hard probe on a point that lies in **Plane 3**, then click the **green** button on the scanner. There is no need to select a second or third point on **Plane 3**.

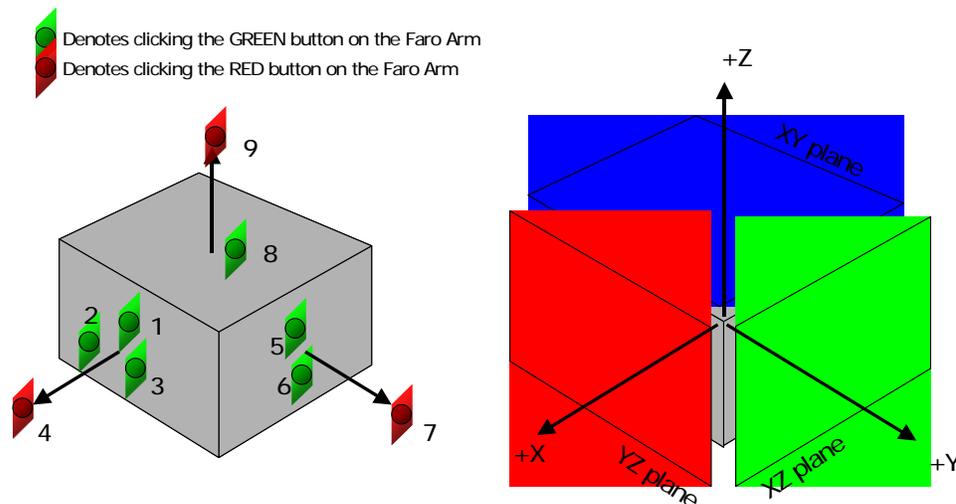
- Pull the probe out and away from **Plane 3**, then click the **red** button on the scanner.

Based on the right-hand rule, the software already knew the + and - side of **Plane 3**, but this was necessary to complete the process.

- The current coordinates of the probe appear in a coordinate indicator box. Move the indicator box by dragging it to any location of the screen, or click the **red** button to close the indicator. Click **Show Coordinates** to re-display the coordinate indicator box.
- Hover the probe above the YZ plane and verify that the X coordinate in the indicator is appropriately positive or negative.
Hover the probe above the XZ plane and verify that the Y coordinate in the indicator is appropriately positive or negative.
Hover the probe above the XY plane and verify that the Z coordinate in the indicator is appropriately positive or negative.
- Coordinate system definition is complete. To un-do the coordinate system, click **Reset** and go to Step 2.

Detailed Example

To specify the YZ plane (with a total of four points), then the XZ plane (with a total of three points), then the XY plane (with two points): Designate Plane 1 by clicking the **+X** icon, then designate Plane 2 by clicking the **+Y** icon. The software automatically designates Plane 3 as **+Z**. Make nine clicks, some **green** and some **red**, according to the illustration below.



FARO Scan -- Step-by-Step

- Click the **Laser Scanning** icon.



2. In the **Current Probe** pulldown, select **Laser Probe** then click **OK**.
3. To configure the scanner, click the **Scanner Options** icon  and see the FARO documentation. To exit the options window, click **OK**.
4. Set the controls on the **Faro Scanning Dialog**.
5. To perform a scan and thus create an object in the Geomagic model manager:
 - Click the **Start Capture** icon  .
 - Click the **green** button on the scanner and make scan passes.
 - The first scan pass does not appear in the Viewing Area until **green** is pressed a second time.
 - During the scanning process, use the on-screen range finder or the LEDs on the scanner to keep the scanner at a suitable distance from the physical object.
 - At any time, click the **green** button again to pause scanning. The scan arm acts as a mouse when scanning is not active. Click the **green** button to resume scanning.
 - Click the **red** button to end scanning. The scan arm behaves like a mouse.

Datum and Feature Creation -- Step-by-Step

Datums and features can be created by use of this FARO scanner plug-in software, *or* by the use of tools that are native to the Geomagic products. In theory, datums or features can be identified more precisely by touching the original object and by use of the FARO plug-in. Depending on the accuracy of the scan and the user's experience, however, it may be advantageous to create datums and features using the native Geomagic tools. To create datums and features using the FARO scanner software:

1. Click the **Hard Probing** icon. 
2. In the **Current Probe** pulldown, identify the currently installed hard probe, such as **3mm Ball Probe**, then click **OK**.
3. Click the icon of a datum type or feature type to be created.
4. Check (or uncheck) the **Show Instructions** box for guidance on how to create each datum or feature type. Instructions also appear below. A summary of the instructions is:
 - Click the **green** button to make choices.
 - Click the **red** button to finalize choices and go on to the next step.

- When you have finished creating all datums and features, click the **red** button again.

NOTE: When defining several features on the same plane, you do not need to define that plane for each feature. To recall the last defined plane, click on the plane with a single **green** click followed by a **red** click.

Creating a DATUM PLANE

1. Click the datum **Plane** icon. 
2. Define a plane by clicking **green** on 3 or more points on the surface of the object.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Repeat steps 2 and 3 to define other planes, or click **red** to return to the dialog.

Creating a DATUM AXIS Using CYLINDER Method

1. Click the datum **Axis** icon. 
2. Click the **Cylinder** method icon. 
3. Define a cylinder by clicking **green** on 6 or more points on the surface of the object.
4. Define the axial direction by clicking **red** on a single point inside or outside the cylinder.
5. Repeat steps 3 and 4 to define other axes, or click **red** to return to the dialog.

Creating a DATUM AXIS Using CONE method:

1. Click the datum **Axis** icon. 
2. Click the **Cone** method icon. 
3. Define a cone by clicking **green** on 6 or more points on the surface of the object.
4. Define the axial direction by clicking **red** on a single point inside or outside the cone.
5. Repeat steps 3 and 4 to define other axes, or click **red** to return to the dialog.

Creating a DATUM POINT Using SPHERE Method

1. Click the datum **Point** icon. 
2. Click the **Sphere** method icon. 
3. Define a sphere by clicking **green** on 4 or more points on the surface of the object.
4. Click **red** on a single point inside or outside of the sphere.
5. Repeat steps 3 and 4 to define other points, or click **red** to return to the dialog.

Creating a DATUM POINT Using CENTROID Method

1. Click the Datum **Point** icon. 
2. Click the **Centroid** method icon. 
3. Click **green** on 3 or more close points on the surface of the object.
4. Define the offset direction by clicking **red** on a single point above the group of points.
5. Repeat steps 3 and 4 to define other points, or click **red** to return to the dialog.

Creating a FEATURE CIRCLE

1. Click the feature **Circle** icon. 
2. Define a plane by clicking **green** on 3 or more points on the surface of the object.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Click **green** on 3 or more points on the cylindrical wall perpendicular to the plane.
5. Define the offset direction by clicking **red** on a single point inside the circle (to make a hole) or outside the circle (to make a protrusion).
6. Repeat steps 2 through 5 to define other circles, or click **red** to return to the dialog.

Creating a FEATURE SLOT

1. Click the feature **Slot** icon. 
2. Define a plane by clicking **green** on 3 or more points on the surface of the object using the **green** button.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Click **green** on 3 or more points on the cylindrical wall of one end of the slot perpendicular to the plane.
5. Define the offset direction by clicking **red** on a single point inside the slot (to make a hole) or outside the slot (to make a protrusion).
6. Repeat steps 4 and 5 to define the opposite end of the slot.
7. Repeat steps 2 through 6 to define other slots, or click **red** to return to the dialog.

Creating a FEATURE RECTANGLE

1. Click the feature **Rectangle** icon. 
2. Define a plane by clicking **green** on 3 or more points on the surface of the object using the **green** button.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Click **green** on 2 or more points on one of the rectangular walls perpendicular to the plane.
5. Define the offset direction by clicking **red** on a single point away from the rectangle wall.
6. Repeat steps 4 and 5 for the remaining three walls, working in a counter-clockwise order.
7. Repeat steps 2 through 6 to define other rectangles, or click **red** to return to the dialog.

Creating a FEATURE LINE

1. Click the feature **Line** icon (for the intersection of two planes) 
2. Click **green** on 3 or more points on the surface of the object.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Click **green** on 2 or more points on a rectangular wall perpendicular to the plane.
5. Define the offset direction by clicking **red** on a single point away from the wall.
6. Repeat steps 2 through 5 to define other lines, or click **red** to return to the dialog.

Faro Scanning with Geomagic Qualify

The fundamental purpose of Geomagic Qualify is computer-aided inspection. The Plugins > Faro Scan utility for Geomagic Qualify allows a reference object to be scanned, the coordinate system to be saved in the reference object file, the coordinate system to be re-loaded before scanning a test object, and the test object to be scanned and automatically compared to the reference object. This workflow avoids the need to constantly deal with alignment of reference and test objects, load data files and designate them as reference or test, and perform the analyses - all in separate steps.

This section describes the concepts and a typical workflow for computer-aided inspection with Geomagic Qualify and FARO scanning equipment. The purpose of this procedure is to simplify the alignment of a reference object and many test objects by using the hard probe to identify datums and features on the reference object and on many test objects and by allowing the software to align the objects by hardware-generated datums and features.

1. Start Geomagic Qualify.

The first goal is to open a CAD object that will serve as the reference object.

2. Open a CAD object. It is assumed that the CAD object exists at appropriate coordinates in the world coordinate system. (If the CAD object does not automatically become the Reference object in the model manager, designate it as the Reference object by right-clicking it and selecting **Set Reference**.)
3. Use **Tools > Datums > Create Datums** or **Tools > Features > Create Features** to define important areas of comparison on the CAD object.

By using the hard probe on a test part that is mounted on the test fixture, you will establish the position of the datums and features with respect to the test fixture. You will not scan a test part yet.

4. Start **Plugins > Faro Scan**.

5.  Click the large **Hard Probing** icon, indicating that you will use the touch probe next.
6. Mount a test part on the test fixture. Using the hard probe, define two or more features or datums (for details, see [Datum and Feature Creation -- Step-by-Step](#) on 1-13). Recall that no test object exists in the model manager, and you are not laser scanning a test part -- you are creating a special "blank" test object named "Features/Datums" that records the position of the datums and features with respect to the test fixture.

7. Exit the plugin by clicking the **OK** button. In the model manager, note the existence of the CAD object and a new test object called "Features/Datums". Note the existence of Feature and Datum sub-objects under the Features/Datums object.

The next goal is to detect the spatial difference between the reference object and the place where an actual test object will rest on the test fixture.

8. Use **Tools > Alignment > Datum/Features Alignment** on the test and reference objects (which aligns the reference object with the special test object by aligning their datums and features). The side effect of this process is that it creates an internal *transformation matrix*, which is a mapping of the spatial difference between the reference object and the place where an actual test object will rest on the test fixture.

The next goal is to prepare for the scanning of an actual test part. You will instruct the plugin that the spatial orientation of the real test part will be the same as that detected in the alignment process in step 8.

9. Select **Plugins > Faro Scan** again, and click the large **Alignment** icon.
10. Click the "Use Last Test Alignment" button. This establishes the orientation of the next scan to be the same as the existing test object.
11. Click the **Merge Features/Datums to Next Scan** checkbox. This causes the features and datums that exist in the Feature/Datum object to be replicated into the object created during the next scan.

Next, scan a test part.

12.  Click the large **Laser** icon to activate scanning mode. Begin scanning. For details, see [FARO Scan -- Step-by-Step](#) on 1-12. Scan data appears on the screen in alignment with the CAD reference object.
13. Exit the plugin by clicking the **OK** button. In the model manager, notice that the newly created scan object is now the test object.

Perform repetitive scanning of test parts.

14. To scan and rapidly align another test object, select **Plugins > Faro Scan** again and go to step 12.

FARO Scanning Plugin

for Geomagic Studio 6 service release 4, Geomagic Qualify 6 service release 2,
and Geomagic Qualify 7

Document version B

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The FARO scanner is a seven-axis measurement device from FARO Technologies, Inc. that offers full scanning or select data-gathering without the user having to interchange parts. **Plugins > Faro Scanning** is an interface to the FARO scanner. The purpose of this plug-in is to integrate data capture and processing activities into a single user interface. Specifically, the Faro Scanning function in Geomagic products allows data capture and storage to the model manager in a single step, and the creation of datums and features on the scanned object.

(This menu item in Geomagic products is an optional, separately licensed feature. If Faro Scan does not already appear on the Plugins menu, download the software from support.geomagic.com/downloads, install it according to simple instructions on the web site, and re-start this procedure.)

Turn on the FARO scanner *before* selecting **Plug-ins > Faro Scanning**.



In This Document:

- For reference information on the controls and indicators of the FARO Scanning plug-in, see [Controls and Indicators](#) on 1-2.
- Immediately after activating the Faro Scanning plugin, a popup might prompt you to "reference the encoders". See [Referencing the Encoders](#) on 1-6.
- From time to time, especially after moving the scanner to a new location, you will calibrate the hard and laser probes. See [Calibrating the Hard and Laser Probes](#) on 1-6.
- Reverse engineering with Faro Scanning and **Geomagic Studio** - see [FARO Scan -- Step-by-Step](#) on 1-12.
- Datum and feature creation with Faro Scanning and **Geomagic Studio** or **Geomagic Qualify** - see [Datum and Feature Creation -- Step-by-Step](#) on 1-13.
- Computer-aided inspection with Faro Scanning and **Geomagic Qualify** - see [Faro Scanning with Geomagic Qualify](#) on 1-17.

Controls and Indicators

This section details the controls and indicators on the user interface of the FARO Scanning plug-in.

-  **Alignment** icon button - activates controls and indicators for the alignment process. Every scan must be performed with respect to a known spatial orientation (also called a “coordinate system”, also incorrectly called an “alignment”). The spatial orientation remains in effect on subsequent scans and the next time Geomagic Studio or Qualify is started. Define an orientation by one of the following four methods.
 - **Select Probe** group -
 - **Probe** button - presents a popup window in which you specify the physical probe that is attached to the FARO arm. In the Select Probe window, identify the currently installed hard probe (such as **3mm Ball Probe**). Optionally, perform calibration of that probe. Click **OK**.
 - **3-2-1 Alignment** button - Allows the user to establish spatial orientation by defining the position of the X, Y, and Z planes. See [3-2-1 Alignment](#) on 1-10.
 - **Last Test Model Alignment** button (selectable only when an object has been designated as the test object, or when a Feature/Datum object is present in the model manager) - specifies that the spatial orientation be based on the scheme of an existing object. In Geomagic **Qualify**, use the orientation of the currently designated test object. If no test object exists, use the spatial orientation of the Feature/Datum object. If this is Geomagic **Studio**, use the spatial orientation of the Feature/Datum object.
 - **Merge Features/Datums to Next Scan** checkbox (functional only when a Feature/Datum object exists) - causes the features and datums that exist in the Feature/Datum object to be replicated into the object created during the next scan.
 - **Load Transform** - allows the user to select a .tfm or .xal file that defines a spatial orientation.
 - **Use Arm CSYS** - sets the spatial orientation (also called Coordinate SYSTEM) to the arm default, where the arm base is the origin.

-  **Laser** icon button - activates controls and indicators for the laser scanner.
 - **Object Name** field and **Reset** button - indicates the name of the object that will be stored in the Geomagic model manager. **Reset** does something.
 - **Laser Scanning** group -
 -  **Calibrate Scanner:** Click this if calibration is required for the hard probe and laser probe, or just the laser probe. In response to the prompt, press a radio button to specify the extent of calibration that is required.
 - **Hard Probe Sphere Calibration** - Neither the hard probe nor the laser scanner have been calibrated. Press this button to be taken to the beginning of the hard probe calibration process, then to the laser scanner calibration process.
 - **Measure Sphere With Current Hard Probe** - The hard probe has been calibrated, but it is now clamped to the table in a different position with respect to the base of the arm. Press this button to be taken to the positioning part of the hard probe calibration process, then to the laser scanner calibration process. This is the same as selecting **Alignment | Probe button | Sphere Calibration** or **Hard Probe | Probe button | Sphere Calibration**.
 - **Use Previous Values** - The hard probe has been calibrated and it is still clamped to the table in the same position with respect to the base of the arm. Press this button to be taken to the laser scanner calibration process.
 -  **Scanner Options:** Brings up the Faro dialog that allows specific adjustment of the laser scanner operations.
 -  **Start Scan** button - puts the scanner and software into data collection mode. To return to the application, press the **red** button on the scanner. To actually begin scanning, press the **green** button. To pause, press the **green** button again.
 - **Units** - specifies the units of measure on the object that will be scanned, such as inches or millimeters.

- **Scanning Options** - control the operation of the scanner and the display of data.
 - **Shade Points** checkbox - By the time a scan is stored in the model manager, the plugin will have calculated individual point normals based on the scanner direction at time of acquisition. This checkbox specifies whether to perform these calculations during pauses (in which case you must wait for a calculation to complete before resuming a scan) or after you press OK to store the object in the model manager (in which case you might have to wait for a relatively long time).
 - **Virtual Camera** checkbox - toggles the Virtual Camera functionality of the laser scanner.
 - **Highlight Scan Pass** checkbox - toggles scan pass hi-lighting. When selected, the incoming scan data will appear red, otherwise the incoming scan data will match the light green of previously created scan passes.
 - **Display Polygons** checkbox - toggles the display between Polygons and Points. Acts on all scan passes in the current plugin instance.
 - **Edge Ratio** slider (five settings from Low to High) - specifies the propensity of the software to leave gaps between scan lines in the scan image if you are scanning too fast. [A triangle with *high edge ratio* is one that has two relatively long sides caused by rapid scanning, and a relatively short side which is influenced by the scan line density setting on the FARO Scanner Settings dialog.]
 - When density of scan is more important, such as in a reverse engineering scenario, use a lower Edge Ratio. If you scan too fast, gaps will appear on the scan image. In that case, slow down or make a second pass.
 - When density of scan is less important, such as some inspection scenarios, use a higher Edge Ratio. If you scan relatively fast and scan lines are far apart, software will triangulate the space between scan lines and thereby suggest that the scan is "good". If you are still scanning too fast and gaps appear, slow down or make a second pass.

- **Data Options** - affect the appearance of collected data *after* the plugin is closed.
 - **Merge Scan Passes** checkbox - specifies whether to perform a point merge on all individual scan passes created during the current session of the plugin. The result will be one point object in the model manager.
 - **Sampling** checkbox - specifies whether to perform uniform sampling (a reduction of point density) on the resulting point cloud at the end of a scan pass.
 - **Spacing** - specifies the spacing parameter used by the Uniform Sample operation.
 - **Smoothing** slider (None, Min, Med, and Max) - specifies whether to perform a smoothing operation on each scan line as it is received from the scanner. The intent is that noisy data can be smoothed in real-time to provide better wrapping results. The values are: None, Min, Med, Max.
 - **Filter Angle** field (0 to 90 degrees) - offers the ability to ignore points collected by the scanner beyond the specified angle. This results in much cleaner data. The filter angle can be adjusted between 0.0 and 90.0 degrees. This operation, like smoothing, is on a per scan line basis.

-  **Hard Probe** icon button - activates controls and indicators for the touch probe on the scanner's nose.
 - **Object Name** field and **Reset** button - indicates the name of the object that will be stored in the Geomagic model manager. **Reset** does something.
 - **Select Probe** group -
 - **Probe** button - presents a popup window in which you specify the physical probe that is attached to the FARO arm. In the Select Probe window, identify the currently installed hard probe (such as **3mm Ball Probe**). Optionally, perform calibration of that probe. Click **OK**.
 - **Datum/Feature Type** group - specifies the kind of datum or feature that will be defined by use of the hard probe. A datum or feature can be defined even if no scan data exists yet. If no scan data yet exists, an "empty" point object called Datums/Features is created in the model manager and the new datum and feature sub-objects are stored under it.
 - **Method Input** group - specifies the kind of datum or feature that will be defined by use of the hard probe. A datum or feature can be defined even if no scan data exists yet. If no scan data yet exists, an "empty" point object called Datums/Features is created in the model manager and the new datum and feature sub-objects are stored under it.

- **Show Instructions** checkbox - specifies whether the user interface presents a sentence explaining how to define the datum or feature given the Datum/Feature Type and the Method Input that is chosen.
- **Instructions** (if requested by the Show Instructions checkbox) - presents a sentence explaining how to define the datum or feature given the Datum/Feature Type and the Method Input that is chosen.

Referencing the Encoders

If a graphical representation of the FARO arm pops up, you must now “reference the encoders”. Exercise the arm in every direction until the red arrows on the graphical display disappear.

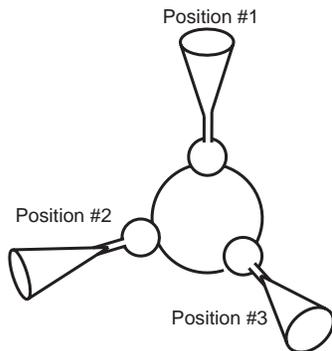
Calibrating the Hard and Laser Probes

From time to time, especially after moving the scanner to a new location, you will calibrate the hard and laser probes.

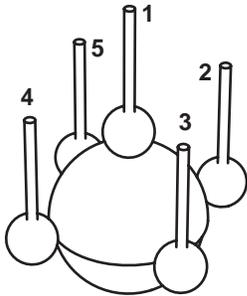
1.   Press the large Laser Scanning icon, then the Calibrate Scanner icon.
2. Before calibrating the laser scanner, the hard probe must be calibrated (or must have been calibrated already). In response to the prompt, select one of the following radio buttons based on the “condition” of the hard probe.
 - **Hard Probe Sphere Calibration** - Neither the hard probe nor the laser scanner have been calibrated. Press this button to be taken to the beginning of the hard probe calibration process, then to the laser scanner calibration process. Go to Step 3.
 - **Measure Sphere With Current Hard Probe** - The hard probe has been calibrated, but it is now clamped to the table in a different position with respect to the base of the arm. Press this button to be taken to the positioning part of the hard probe calibration process, then to the laser scanner calibration process. (This is the same as selecting **Alignment | Probe button | Sphere Calibration** or **Hard Probe | Probe button | Sphere Calibration.**) Go to Step 5.
 - **Use Previous Values** - The hard probe has been calibrated and it is still clamped to the table in the same position with respect to the base of the arm. Press this button to be taken to the laser scanner calibration process. Go to Step 8.

3. In the **Current Probe** pulldown, identify the currently installed hard probe, such as **3mm Ball Probe**, then click **OK**.
4. *If* a graphical representation of the FARO arm pops up, you must now reference the encoders. Exercise the arm in every direction until the red arrows on the graphical display disappear.

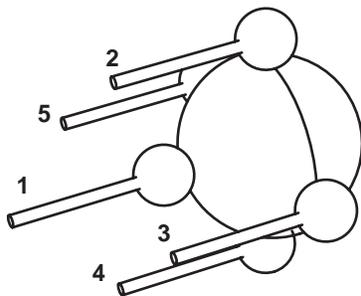
The next three steps refer to Position #1, #2, and #3 as indicated in the following diagram.



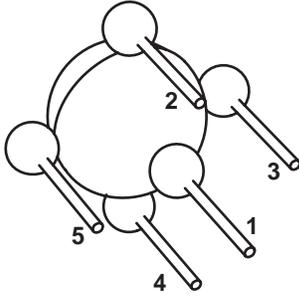
5. In the order indicated by the on-screen illustration, digitize five points around the top of the sphere in probe position number 1.



6. In the order indicated by the on-screen illustration, digitize five points around the front of the sphere in probe position number 2.



7. In the order indicated by the on-screen illustration, digitize five points around the side of the sphere in probe position number 3.

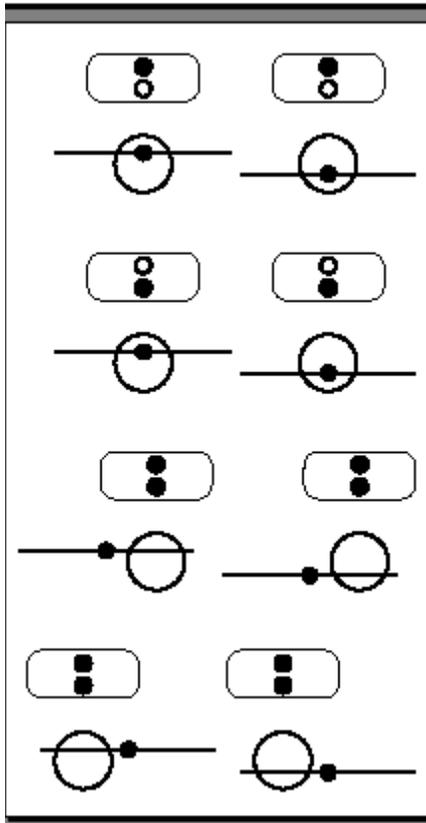


After five points are digitized on each of three angles, an internal calibration process begins.

- If the probe passes the test, the **Calibration Status** is set to Passed and the current date and time appear in the time indicator. Click **OK**. Calibration of the standard (hard) probe is complete.
 - If the probe fails the test, the **Calibration Status** is set to Failed. Click **Retry** and go to Step 5.
8. To calibrate the laser probe, you will digitize eight points from *each* of the three positions, starting with the top view (position 1), a side view (position 2), then the front view (position 3).

Use the on-screen range finder or the two LEDs on the back of the scanner to judge the definition of **Near** range and **Far** range. Starting at position 1, digitize two points in the **Near** range with the **center** of the laser -- one point on the upper half of the calibration sphere and one point on the lower half. The Near range is indicated by the upper green LED on the range finder. The Center range is indicated by both green LEDs on the

range finder. The Far range is indicated by the lower green LED on the range finder.



9. Digitize two points in the **Far** range with the **center** of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
10. Digitize two points in the **Center** range with the **left** side of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
11. Digitize two points in the **Center** range with the **right** side of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
12. Move to position two, which is the left or right side of the sphere.
13. Digitize two points in the **Near** range with the **center** of the laser
14. Digitize two points in the **Far** range with the **center** of the laser
15. Digitize two points in the **Center** range with the **left** side of the laser
16. Digitize two points in the **Center** range with the **right** side of the laser
17. Move to position three, which is the front side of the sphere.
18. Digitize two points in the **Near** range with the **center** of the laser
19. Digitize two points in the **Far** range with the **center** of the laser
20. Digitize two points in the **Center** range with the **left** side of the laser

21. Digitize two points in the **Center** range with the **right** side of the laser After eight points are digitized in each of three positions, an internal calibration process begins.
- If the probe passes the test, the **Calibration Status** is set to Passed and the current date and time appear in the time indicator. Click **OK**. For details on the calibration of both the hard and laser probes, click **View Log** and see the FaroArm USB manual for details. Calibration of the laser probe is complete.
 - If the probe fails the test, the **Calibration Status** is set to Failed. Click **Retry** and go to Step 8.

3-2-1 Alignment

This is a sub-procedure referenced by the Alignment section under [Controls and Indicators](#) on 1-2.

This describes "3-2-1 Alignment" -- how to specify an object's coordinate system by defining the position of three orthogonal planes. The origin of the object's coordinate system will be the point of intersection of the three planes.

1. Click the large  Alignment icon, then the  3-2-1 Alignment icon.

Recall that:

The plane orthogonal to the X axis is the YZ plane.

The plane orthogonal to the Y axis is the XZ plane.

The plane orthogonal to the Z axis is the XY plane.

The *letter* on each of the following icons represents the axis to which a plane is orthogonal. The *sign* on each icon represents a *side* of the plane.



2. If the purpose of this alignment is to synchronize the coordinates a test part with a CAD object, look at the CAD object and ascertain the position of the X , Y , and Z axes (the YZ , XZ , and XY planes) with respect to the CAD object. (Note that a CAD object's coordinate system always uses the right-hand rule).

3. Based on information ascertained in the previous step, perform *any two* of the following three actions:
 - Click the **+X** icon *or* the **-X** icon.
(+X means that "above" YZ is the positive side of YZ.
-X means that "above" YZ is the negative side of YZ.)
 - Click the **+Y** icon *or* the **-Y** icon.
(+Y means that "above" XZ is the positive side of XZ.
-Y means that "above" XZ is the negative side of XZ.)
 - Click the **+Z** icon *or* the **-Z** icon.
(+Z means that "above" XY is the positive side of XY.
-Z means that "above" XY is the negative side of XY.)

The first button you press is designated as **Plane 1**.

The second button you press is designated as **Plane 2**.

Adhering to the right-hand rule, the software automatically selects a third button (either the + or - variant of the plane you didn't pick), and designates it as **Plane 3**. The sign that the software picks is always the sign of **Plane 1** times the sign of **Plane 2**. (+ * + = +) ; (+ * - = -) ; (- * - = +)

4. On the physical object, position the hard probe on a point that lies in **Plane 1**, then click the **green** button on the scanner. Position the probe on a second point that lies in **Plane 1**, then click the **green** button on the scanner. Position the probe on a third point that lies in **Plane 1**, then click the **green** button on the scanner.

You have just defined the position of **Plane 1**.

5. Pull the probe out and away from **Plane 1**, then click the **red** button on the scanner.

If **Plane 1** was designated in Step 3 by a + icon, you have established the + side of **Plane 1**.

If **Plane 1** was designated in Step 3 by a - icon, you have established the - side of **Plane 1**.

6. On the physical object, position the hard probe on a point that lies in **Plane 2**, then click the **green** button on the scanner. Position the probe on a second point that lies in **Plane 2**, then click the **green** button on the scanner. There is no need to select a third point on **Plane 2**.

You have just defined the position of **Plane 2**.

7. Pull the probe out and away from **Plane 2**, then click the **red** button on the scanner.

If **Plane 2** was designated in Step 3 by a + icon, you have established the + side of **Plane 2**.

If **Plane 2** was designated in Step 3 by a - icon, you have established the - side of **Plane 2**.

8. On the physical object, position the hard probe on a point that lies in **Plane 3**, then click the **green** button on the scanner. There is no need to select a second or third point on **Plane 3**.

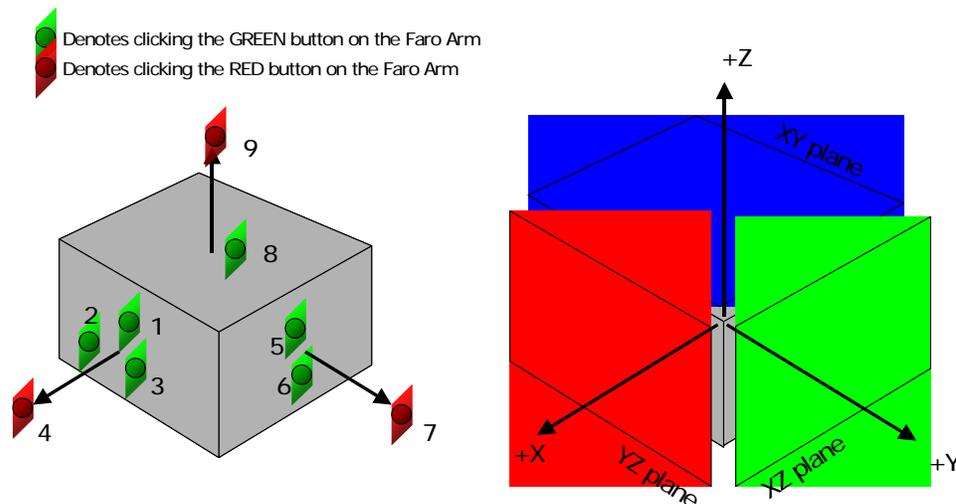
- Pull the probe out and away from **Plane 3**, then click the **red** button on the scanner.

Based on the right-hand rule, the software already knew the + and - side of **Plane 3**, but this was necessary to complete the process.

- The current coordinates of the probe appear in a coordinate indicator box. Move the indicator box by dragging it to any location of the screen, or click the **red** button to close the indicator. Click **Show Coordinates** to re-display the coordinate indicator box.
- Hover the probe above the YZ plane and verify that the X coordinate in the indicator is appropriately positive or negative.
Hover the probe above the XZ plane and verify that the Y coordinate in the indicator is appropriately positive or negative.
Hover the probe above the XY plane and verify that the Z coordinate in the indicator is appropriately positive or negative.
- Coordinate system definition is complete. To un-do the coordinate system, click **Reset** and go to Step 2.

Detailed Example

To specify the YZ plane (with a total of four points), then the XZ plane (with a total of three points), then the XY plane (with two points): Designate Plane 1 by clicking the **+X** icon, then designate Plane 2 by clicking the **+Y** icon. The software automatically designates Plane 3 as **+Z**. Make nine clicks, some **green** and some **red**, according to the illustration below.



FARO Scan -- Step-by-Step

- Click the **Laser Scanning** icon.



2. In the **Current Probe** pulldown, select **Laser Probe** then click **OK**.
3. To configure the scanner, click the **Scanner Options** icon  and see the FARO documentation. To exit the options window, click **OK**.
4. Set the controls on the **Faro Scanning Dialog**.
5. To perform a scan and thus create an object in the Geomagic model manager:
 - Click the **Start Capture** icon  .
 - Click the **green** button on the scanner and make scan passes.
 - The first scan pass does not appear in the Viewing Area until **green** is pressed a second time.
 - During the scanning process, use the on-screen range finder or the LEDs on the scanner to keep the scanner at a suitable distance from the physical object.
 - At any time, click the **green** button again to pause scanning. The scan arm acts as a mouse when scanning is not active. Click the **green** button to resume scanning.
 - Click the **red** button to end scanning. The scan arm behaves like a mouse.

Datum and Feature Creation -- Step-by-Step

Datums and features can be created by use of this FARO scanner plug-in software, *or* by the use of tools that are native to the Geomagic products. In theory, datums or features can be identified more precisely by touching the original object and by use of the FARO plug-in. Depending on the accuracy of the scan and the user's experience, however, it may be advantageous to create datums and features using the native Geomagic tools. To create datums and features using the FARO scanner software:

1. Click the **Hard Probing** icon. 
2. In the **Current Probe** pulldown, identify the currently installed hard probe, such as **3mm Ball Probe**, then click **OK**.
3. Click the icon of a datum type or feature type to be created.
4. Check (or uncheck) the **Show Instructions** box for guidance on how to create each datum or feature type. Instructions also appear below. A summary of the instructions is:
 - Click the **green** button to make choices.
 - Click the **red** button to finalize choices and go on to the next step.

- When you have finished creating all datums and features, click the **red** button again.

NOTE: When defining several features on the same plane, you do not need to define that plane for each feature. To recall the last defined plane, click on the plane with a single **green** click followed by a **red** click.

Creating a DATUM PLANE

1. Click the datum **Plane** icon. 
2. Define a plane by clicking **green** on 3 or more points on the surface of the object.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Repeat steps 2 and 3 to define other planes, or click **red** to return to the dialog.

Creating a DATUM AXIS Using CYLINDER Method

1. Click the datum **Axis** icon. 
2. Click the **Cylinder** method icon. 
3. Define a cylinder by clicking **green** on 6 or more points on the surface of the object.
4. Define the axial direction by clicking **red** on a single point inside or outside the cylinder.
5. Repeat steps 3 and 4 to define other axes, or click **red** to return to the dialog.

Creating a DATUM AXIS Using CONE method:

1. Click the datum **Axis** icon. 
2. Click the **Cone** method icon. 
3. Define a cone by clicking **green** on 6 or more points on the surface of the object.
4. Define the axial direction by clicking **red** on a single point inside or outside the cone.
5. Repeat steps 3 and 4 to define other axes, or click **red** to return to the dialog.

Creating a DATUM POINT Using SPHERE Method

1. Click the datum **Point** icon. 
2. Click the **Sphere** method icon. 
3. Define a sphere by clicking **green** on 4 or more points on the surface of the object.
4. Click **red** on a single point inside or outside of the sphere.
5. Repeat steps 3 and 4 to define other points, or click **red** to return to the dialog.

Creating a DATUM POINT Using CENTROID Method

1. Click the Datum **Point** icon. 
2. Click the **Centroid** method icon. 
3. Click **green** on 3 or more close points on the surface of the object.
4. Define the offset direction by clicking **red** on a single point above the group of points.
5. Repeat steps 3 and 4 to define other points, or click **red** to return to the dialog.

Creating a FEATURE CIRCLE

1. Click the feature **Circle** icon. 
2. Define a plane by clicking **green** on 3 or more points on the surface of the object.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Click **green** on 3 or more points on the cylindrical wall perpendicular to the plane.
5. Define the offset direction by clicking **red** on a single point inside the circle (to make a hole) or outside the circle (to make a protrusion).
6. Repeat steps 2 through 5 to define other circles, or click **red** to return to the dialog.

Creating a FEATURE SLOT

1. Click the feature **Slot** icon. 
2. Define a plane by clicking **green** on 3 or more points on the surface of the object using the **green** button.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Click **green** on 3 or more points on the cylindrical wall of one end of the slot perpendicular to the plane.
5. Define the offset direction by clicking **red** on a single point inside the slot (to make a hole) or outside the slot (to make a protrusion).
6. Repeat steps 4 and 5 to define the opposite end of the slot.
7. Repeat steps 2 through 6 to define other slots, or click **red** to return to the dialog.

Creating a FEATURE RECTANGLE

1. Click the feature **Rectangle** icon. 
2. Define a plane by clicking **green** on 3 or more points on the surface of the object using the **green** button.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Click **green** on 2 or more points on one of the rectangular walls perpendicular to the plane.
5. Define the offset direction by clicking **red** on a single point away from the rectangle wall.
6. Repeat steps 4 and 5 for the remaining three walls, working in a counter-clockwise order.
7. Repeat steps 2 through 6 to define other rectangles, or click **red** to return to the dialog.

Creating a FEATURE LINE

1. Click the feature **Line** icon (for the intersection of two planes) 
2. Click **green** on 3 or more points on the surface of the object.
3. Define the offset direction by clicking **red** on a single point above the plane.
4. Click **green** on 2 or more points on a rectangular wall perpendicular to the plane.
5. Define the offset direction by clicking **red** on a single point away from the wall.
6. Repeat steps 2 through 5 to define other lines, or click **red** to return to the dialog.

Faro Scanning with Geomagic Qualify

The fundamental purpose of Geomagic Qualify is computer-aided inspection. The Plugins > Faro Scan utility for Geomagic Qualify allows a reference object to be scanned, the coordinate system to be saved in the reference object file, the coordinate system to be re-loaded before scanning a test object, and the test object to be scanned and automatically compared to the reference object. This workflow avoids the need to constantly deal with alignment of reference and test objects, load data files and designate them as reference or test, and perform the analyses - all in separate steps.

This section describes the concepts and a typical workflow for computer-aided inspection with Geomagic Qualify and FARO scanning equipment. The purpose of this procedure is to simplify the alignment of a reference object and many test objects by using the hard probe to identify datums and features on the reference object and on many test objects and by allowing the software to align the objects by hardware-generated datums and features.

1. Start Geomagic Qualify.

The first goal is to open a CAD object that will serve as the reference object.

2. Open a CAD object. It is assumed that the CAD object exists at appropriate coordinates in the world coordinate system. (If the CAD object does not automatically become the Reference object in the model manager, designate it as the Reference object by right-clicking it and selecting **Set Reference**.)
3. Use **Tools > Datums > Create Datums** or **Tools > Features > Create Features** to define important areas of comparison on the CAD object.

By using the hard probe on a test part that is mounted on the test fixture, you will establish the position of the datums and features with respect to the test fixture. You will not scan a test part yet.

4. Start **Plugins > Faro Scan**.

5.  Click the large **Hard Probing** icon, indicating that you will use the touch probe next.
6. Mount a test part on the test fixture. Using the hard probe, define two or more features or datums (for details, see [Datum and Feature Creation -- Step-by-Step](#) on 1-13). Recall that no test object exists in the model manager, and you are not laser scanning a test part -- you are creating a special "blank" test object named "Features/Datums" that records the position of the datums and features with respect to the test fixture.

7. Exit the plugin by clicking the **OK** button. In the model manager, note the existence of the CAD object and a new test object called "Features/Datums". Note the existence of Feature and Datum sub-objects under the Features/Datums object.

The next goal is to detect the spatial difference between the reference object and the place where an actual test object will rest on the test fixture.

8. Use **Tools > Alignment > Datum/Features Alignment** on the test and reference objects (which aligns the reference object with the special test object by aligning their datums and features). The side effect of this process is that it creates an internal *transformation matrix*, which is a mapping of the spatial difference between the reference object and the place where an actual test object will rest on the test fixture.

The next goal is to prepare for the scanning of an actual test part. You will instruct the plugin that the spatial orientation of the real test part will be the same as that detected in the alignment process in step 8.

9. Select **Plugins > Faro Scan** again, and click the large **Alignment** icon.
10. Click the "Use Last Test Alignment" button. This establishes the orientation of the next scan to be the same as the existing test object.
11. Click the **Merge Features/Datums to Next Scan** checkbox. This causes the features and datums that exist in the Feature/Datum object to be replicated into the object created during the next scan.

Next, scan a test part.

12.  Click the large **Laser** icon to activate scanning mode. Begin scanning. For details, see [FARO Scan -- Step-by-Step](#) on 1-12. Scan data appears on the screen in alignment with the CAD reference object.
13. Exit the plugin by clicking the **OK** button. In the model manager, notice that the newly created scan object is now the test object.

Perform repetitive scanning of test parts.

14. To scan and rapidly align another test object, select **Plugins > Faro Scan** again and go to step 12.