

Chapter 6: Maintenance and Troubleshooting

Normal Maintenance

EDGE

The EDGE is a precision measurement device that contains many sensitive components, and it should be handled with care. Take the following precautions to prevent problems from developing with your system:

- Place a dust cover over the EDGE when not in use.
- Clean with a dry dust cloth. For heavy dirt buildups, use a *very* small amount of warm water and gently clean the EDGE. Be very careful not to bend the EDGE while cleaning.
- Check the cables for damage to outside insulation, connectors, and pins.
- Do not lubricate the EDGE.

The EDGE is calibrated at FARO's production facility and should only need to be recalibrated after the unit has been subjected to a shock that removes surface material or causes bending. Periodic certification tests should be completed to certify the EDGE accuracy and repeatability. See "*EDGE Certification*" on page 68.

FARO recommends you return your EDGE to a service center, once a year, for our annual certification and a 15 point check up.

Host Computer

The computer is an electronic device containing many sensitive components. It should be handled with care. Here are some steps you can take to prevent damage to your system:

- Never use the computer in harsh environments where it may be subjected to rapid temperature change or excessive dust.
- Never expose the computer to excessive shock or vibration.

- Prevent overheating by keeping the computer's air vents clear of any obstructions.
- Never place anything on top of the computer when it is recharging or operating. This can cause the computer to overheat.
- Do not operate the computer from an AC outlet where voltage fluctuates excessively. Use a power strip with a surge protector.
- Do not use an AC adapter other than the one supplied with the computer.
- Do not push on the LCD screen excessively or subject it to shocks.
- Do not expose the LCD screen to direct sunlight, even through a window.
- Do not hold the computer by the LCD panel.
- Do not try to force the LCD screen beyond its fully opened position.

CAUTION: In the rare event that you should see or smell anything which indicates overheating (smoke or a strange smell), turn off the power immediately and contact your dealer.

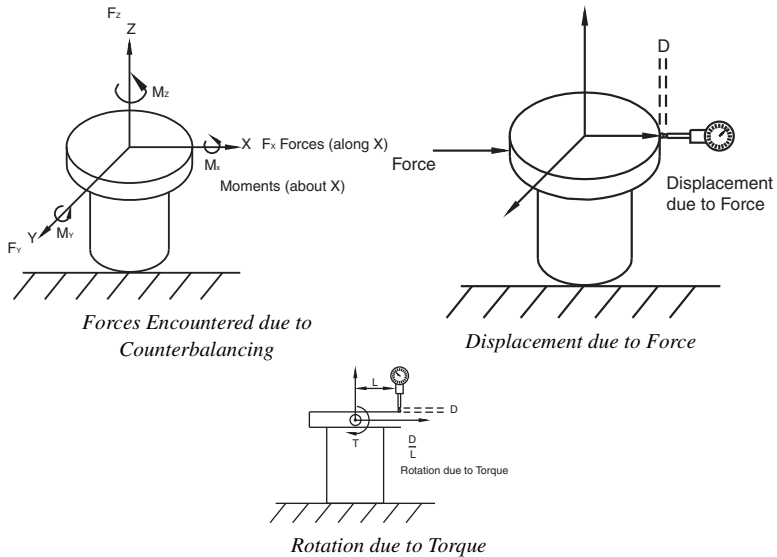
Mounting Stiffness Test

The EDGE is portable and can be mounted in a variety of environments. The EDGE is counterbalanced, and it is the nature of counterbalancing that restoring forces may exist in the mounting due to the applied forces generated by the counterbalancing mechanism. The reaction forces will result in deformations in the mounting, which degrade the performance of the EDGE if the deformations are sufficiently large.

The primary forces encountered due to counterbalancing are translation and torsion. These forces are illustrated below. The forces can be further described along or about the three major axes of a coordinate system at the mounting base. The translation forces (F) along the axes and the moments (M) about the axes result in deformations of the base.

The deformation due to the translation force can be measured. You must apply forces (lb. or N) using a calibrated load cell at the mounting interface to the maximum level required and measure the associated deformation (in. or mm). The torsional forces or moments at the base are generated by using a calibrated torque wrench. The deformations can be described as a slope (in./in. or mm/mm) and can be measured.

The deformations must not exceed the deformation reported at certification.



In general, the excessive translation deformations are added directly to the certified accuracy, while the excessive angular deformations of the base affect accuracy as a more complicated trigonometric function of the length of the reach.

Temperature Considerations

FARO was awarded the U.S. patent #5,402,582, and worldwide patents are pending, on the concept and the methods for temperature compensation of portable CMM devices. This brief overview is meant only as the most general of descriptions.

To maintain certified accuracy in a multitude of environments, the monitoring of temperature and the rate of temperature change is required. Only the EDGE employs a software/hardware solution where a semiconductor temperature sensor is built into each joint.

The temperature is continuously monitored and the difference over time is then applied to the mathematical formulas or kinematics, which define the position of the EDGE in three-dimensional space. Link length corrections are made constantly by the inboard processor, which adjusts

the kinematics and constantly adapts the output to changing environmental temperature.

However, because different components heat or cool at different rates, the device is expected to reach a steady state temperature within a ± 3 degree (Celsius) bandwidth for five minutes before measurements can be taken. For convenience, the electronics system is programmed to generate an error message when the temperature exceeds a ± 3 degree bandwidth. There is also a built-in routine for the establishment of temperature stability; whereby, the device monitors itself for five minutes and indicates to the user that it is ready for use.

Electrostatic Discharge (ESD)

Electrostatic Discharge (ESD) refers to pulses generated by the discharge of loaded objects and/or people. The charge usually comes from friction between materials, at least one of which is a nonconductor.

- Although these units are protected against damage by ESD, extra care and proper ESD procedures still must be observed and followed.

If an error occurs because of ESD, check the Error Message displayed on the screen and follow the steps below to resume normal operation. If you experience anything out of normal operation:

- 1 Turn off the EDGE.
- 2 Wait for at least five seconds before powering the unit on.

This should restore communication with the host computer.

ESD Best Practices

The following is a list of equipment and best practices to avoid ESD events.

Wrist Straps - Wrist straps fit snugly around a person's wrist and are connected to an ESD ground point (never earth ground) or to a grounded

mat. A poor connection with a wrist strap is associated with a loose fit or dry skin (use an ESD lotion for dry skin). A wrist strap may be used if an approved ESD smock is not available. However, wrist straps do not shield ESD sensitive components from damage induced by the wearer's clothing.

Heel Straps - Heel straps should be placed so that they make contact with a person's ankle. Static charges are dissipated through the floor by means of a Conductive Flooring. When seated, heel straps do not offer the protections required to dissipate a static charge.

ESD Lotion - ESD lotion provides a better connection between the user and a smock, heel strap or wrist strap. This may need to be reapplied if the smock or straps are removed.

Smocks - ESD smocks are designed to dissipate static fields created by a wearer's shirt. These must be worn at all times within an ESD Sensitive area. All buttons must be secured when working. Smocks are to be connected to an ESD ground point (never earth ground) or to a grounded mat. While the smock is connected and properly grounded, wrist straps are unnecessary.

ESD Chairs - ESD chairs have a ground strap which comes in contact with a grounded mat or conductive flooring and dissipates charges safely to ground.

Table Mats - Table mats are made of a dissipative material and must be grounded individually to earth ground.

Hand Tool Requirements - Hand tools must be stored in non-insulating or charging stations. New hand tools should be ESD-safe (non-generating and dissipative).

Floor Mats - Floor mats are made of a dissipative material and must be grounded individually to earth ground. This is required if no conductive flooring is installed.

Ground Connections - Any earth ground connection is sufficient.

Conductive Flooring - Conductive flooring must be installed per manufacturer specifications and be connected to earth ground.

Wrist/Heel Strap Tester - These provide a method for checking the function of smocks, heels straps and cable connections on an individual user.

Ionizers - An Ionizer floods the air with positive and negative ions, which eliminate static charges. This must be installed so that the airflow

blows across the workbench (or down on the workbench for overhead units).

Constant Ground Monitors - Constant monitors are connected to a workstation mat and operator and will sound an audible alarm if any ground is interrupted.

Troubleshooting

Error message on host computer.

- Contact FARO's Customer Service by Phone, Fax or E-Mail. See *"Technical Support"* on page 119. Have the message ready.

Probe calibration fails.

- Check that the diameter stamped on the probe tip matches the tip of the current probe. See *"Edit Probe"* on page 102.
- Make sure the EDGE probe is secure. Only *hand-tighten* the probe with the 12mm wrench. *Do not* over-tighten the probe.
- Make sure that the calibration hole, cone or sphere is located about 2/3 the distance of the EDGE from the base.
- Make sure that the calibration cone, or sphere, is securely screwed into the holder and that the holder is securely fastened to a stable surface.
- Make sure that probe tip is in contact with hole, cone or sphere.
- Calibrate the probe again, and check that all points were digitized properly.
- Use the other calibration method (sphere or hole).

Buttons (FRONT & BACK) will not respond.

- Make sure that all of the encoders are referenced. See *"Referencing the Encoders"* on page 31.
- Turn auxiliary port OFF. See *"Edit Probe"* on page 102.
- Check buttons in Diagnostic command. See *"Diagnostics"* on page 114.

Single-point certification shows excessive error.

- You must use a ball probe. Check that it is installed correctly. See *"Installing Probes"* on page 36.
- Recalibrate probe. See *"Compensate Probe"* on page 104.
- During the test, watch the probe to ensure flush seating in the hole. See *"EDGE Certification"* on page 68.

EDGE records points without pressing either button.

- Re-seat the set screw in the EDGE handle. If the set screw is not seated correctly it causes intermittent contact to the pin underneath, and random points are taken.

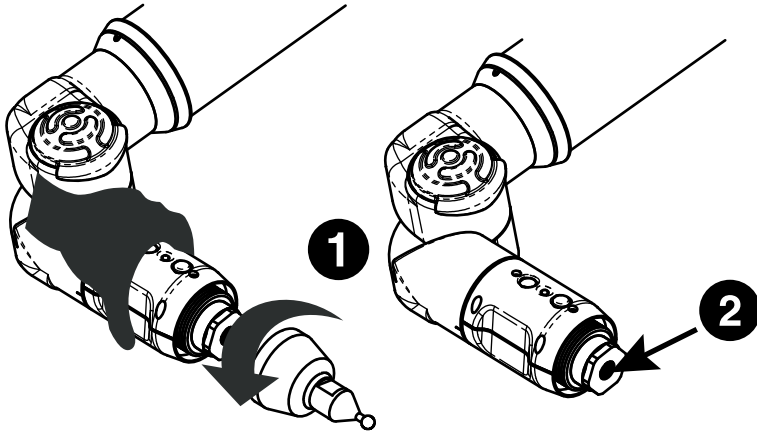


Figure 6-1 Handle Screw

- 1 Remove any standard EDGE probe.
- 2 Remove the set screw using a flathead screwdriver.
- 3 Replace the screw.

NOTE: Be careful not to bottom out the screw. This may cause the pin underneath to be constantly depressed possibly damaging the EDGE.

- 4 Replace the EDGE probe.

Power Issues

If the EDGE is receiving power from the power source, or outlet, but not powering up the system, the source of this issue may lie in one or all of the following areas:

- Ensure you are using the correct cables.
- Check the cables and connectors for bent pins or damage and ensure that the connectors are secure. Replace all cables that show signs of damage.
- Check the power source (outlet) for proper voltage, current and grounding. *For more information, see “EDGE Power Supply” on page 14.*

- Check the power supply for physical impacts or damage. *DO NOT* use a damaged power supply.
- Check functionality of the EDGE. Look for error codes or operation issues.

NOTE: Power surges, spikes, feedback, and fluctuation in the power source will affect the equipment and its electronic accessories. Have your power source inspected by a professional to provide the cleanest power source possible.

Hardware Communication Issues

This section describes the many issues that prevent good communication between the EDGE and the host computer.

PLEASE READ BEFORE BEGINNING THE PROCESS

If communication between the computer and the EDGE is lost, or if it could not be established, the source of this issue may lie in one or all of the following areas:

- Ensure you are using the correct cables.

NOTE: EDGES cannot be adapted by a USB to Serial/Parallel adapter to work on those ports.

- Check the cables and connectors for bent pins or damage and ensure that the connectors are secure. Replace all cables that show signs of damage.
- Check that unauthorized software or hardware is not conflicting with communications; PDAs, digital cameras, scanners, zip drives, modems and external devices are known to cause these conflicts.
- Check that only the EDGE software is running on the computer. Ensure multiple sessions of the measuring software is not running.
- Check functionality of the EDGE. Look for error codes or operation issues.
- Check functionality of power supply or serial box. Look for error codes or damage to the housing.

- Check functionality of computer's hardware.
- Check power source for proper voltage, current and grounding. Remove any extension cords and ungrounded cables.
- Check area to eliminate interference. Large motors, welders or items that may cause vibration or spikes in the power source.

FARO Wireless Connection Issues

- You have setup your connection using your platform specific Bluetooth Wizard and the FARO Bluetooth Connection Setup utility, but software application does not find the EDGE.

1 Make sure the EDGE is receiving power and the On/Off switch is set to the *ON* position. When the On/Off switch is first set to the *ON* position, the blue LED on the front of the EDGE should blink momentarily.

2 If you are using a Bluetooth USB dongle make sure it is plugged into a USB port. Also make sure the software associated with the dongle is running. If you are unsure about this, contact the vendor who supplied the Bluetooth hardware and software.

3 Open the platform specific Bluetooth Wizard and make sure the EDGE is still in the list. If not, refresh the list.

If the EDGE is switched on and the PC's Bluetooth hardware is connected correctly, and the connection is still unavailable contact FARO's Customer Service.

4 Open the platform specific Bluetooth Wizard and check which COM port is configured with the EDGE.

5 Open the FARO Bluetooth Connection Setup utility program and confirm the COM port setting. Ensure it matches the same port in the platform specific Bluetooth Wizard list.

Click OK. If the test passes, the EDGE should work normally. If the test fails, contact FARO's Customer Service.

If the test passes but your software still does not connect, make sure your EDGE driver software is current. The latest driver software may be on a separate CD-ROM that came with your Bluetooth equipped EDGE, or any other FARO software package. If you are unsure about what version of the EDGE driver you are running contact your Customer Service

Representative by Phone, Fax or E-Mail. See “*Technical Support*” on page 119.

- You are within the maximum 30' Bluetooth range, but cannot get a reliable connection.
 - 1 Bluetooth works with a radio frequency, or RF, signal which can be blocked by obstructions. Metallic obstructions are especially degrading to the signal. For best results, ensure you have a clear path between your computer and the EDGE.

FARO Wireless FAQ

- How fast is the connection?

1 Megabit/second.
- What is the range of the FARO Wireless connection?

Approximately 30 feet or 10 meters.
- How many simultaneous Bluetooth wireless connections can be established with the EDGE driver?

Two.
- Can both USB and Bluetooth wireless EDGES be connected simultaneously?

Yes.
- Can a single EDGE connect using both Bluetooth wireless and a USB cable at the same time?

No. If both are properly connected, the Bluetooth wireless will be the only active connection for that EDGE.
- Can I use a FARO Laser Line Probe with the FARO Wireless connection?

Yes.
- Can I add a Bluetooth wireless connection while the EDGE driver is already running?

No, the EDGE driver must be unloaded before changing any FARO Wireless settings.
- Why does it take longer for my measuring software to open when I use the FARO Wireless connection?

The EDGE driver requires more time to initialize when using a FARO Wireless connection and this translates into slightly increased load times for the measuring software.

- Why does it take longer for the PROBES dialog box to go away when I am using a FARO Wireless connection.

Probe data saves in the EDGE and requires more time for this information to transfer when using the FARO Wireless connection.

- What happens if I go out of range and lose my connection? What happens if I turn off the EDGE while it is connected using the FARO Wireless connection?

Once the EDGE driver detects that the EDGE is no longer connected, after about 10 seconds, a message appears asking if you want to restore the FARO Wireless connection. If you click No, the connection stops. If you click Yes, attempts are made to restore the connection.

- Why do I continue to see the message asking if I want to continue to use the FARO Wireless connection?

Either the EDGE has lost power, or it is out of the 30 feet or 10 meters wireless range. After correcting the problem, click Yes to restore the connection.

FARO i-Probe FAQ

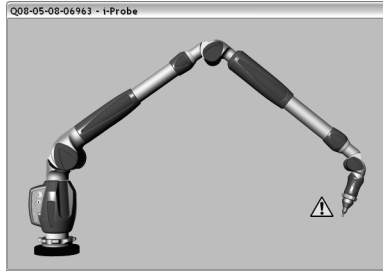
- Can I use an i-Probe on anything other than the EDGE?

Yes. ONLY on a Quantum series FaroArm. Installing the i-Probe to anything other than a Quantum series FaroArm damages the i-Probe.

- Can I still use my old probes on the EDGE?

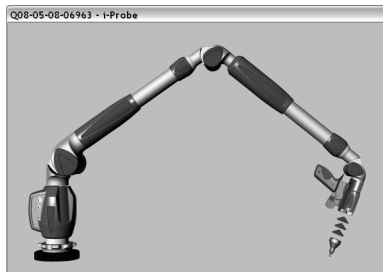
Yes. However you must clear the USE I-PROBE check box in the PROBE dialog box. *For more information, see “Probes” on page 101.*

- I have an i-Probe attached but see this error dialog box and can not measure. What is wrong?



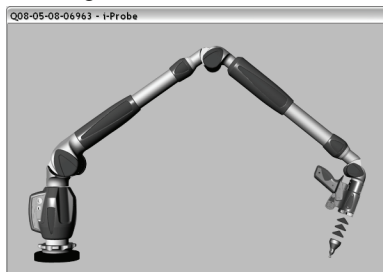
Calibrate the i-Probe. *For more information, see “Compensate Probe” on page 104.*

- I have an i-Probe attached but see this error dialog box and can not measure. What is wrong?



Ensure that the i-Probe is threaded on all the way. If the system still does not recognize it, the i-Probe may be damaged and may need to be replaced.

- I have an old probe attached but see this error dialog box and can not measure. What is wrong?



You must clear the USE I-PROBE check box in the PROBE dialog box. *For more information, see “Probes” on page 101.*

- How many i-Probes can a EDGE remember?

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EDGE/ScanArm Performance Verification Checklist

If you are experiencing accuracy or repeatability problems with your EDGE or ScanArm system, this section details proper setup techniques to help you identify the potential sources of error.

It is important to clearly understand all the “do's and don'ts” in order to get the most out of every EDGE and ScanArm system.

Issues That Will Degrade Accuracy

Mounting

- 1 Deflection in mounting.
 - Do not mount to any type of wooden surface.
 - Do not mount to optical tables such as a “Vibraplane.” The steel sheet on the top of these tables is thin and will deflect.
- 2 Folding tripods without using the stabilizing struts are unstable.
- 3 Heavy-duty stands with wheels down and pins up are unstable.
- 4 Part deformation due to excessive clamping force.

Calibration

- 1 Deflection of calibration artifact.
- 2 Damage to calibration artifact.
 - Do not drag the probe over the FARO Calibration Plate during the plane measurement. Lift the probe in between points to avoid scratching the surface of the plate.
- 3 Poor probe calibration technique.
 - Do not do short sweeps with the FARO Laser Line Probe during calibration.
- 4 Dirty lens.
 - Clean the top and bottom lenses with the cloth from the FARO Laser Line Probe Case. Dirt and grease on either lens can cause poor results.

Probes

- 1 Measuring with Point Probes.
- 2 Measuring with chipped, loose or cracked ball probes.

- 3 Measuring with Probe extensions. The extensions will deflect.

Measurement Environment

- 1 Measuring close to an end stop can induce unwanted stress.
- 2 Binding or hyper-extending the EDGE can cause unnecessary stress.
- 3 “Leap Frogging” or repositioning the device using the Move Device Position command.
- 4 Excessive vibration in the surrounding area can produce unwanted results.
- 5 Rapid changes in ambient temperature can cause errors in the EDGE's automatic temperature compensation.
- 6 Measuring using poor techniques; minimum number of measured points per feature, moving while recording individual points, small coverage area, etc.

NOTE: If the EDGE is mounted on granite, do not measure objects that are not mounted to the granite.

EDGE Setup

- Turn equipment on and allow to warm-up for at least 30 minutes.
- Check that ambient temperature is not fluctuating more than 3°C (5.4°F) over a five minute period.
 - In CAM2 Measure, run the DEVICES >TEMPERATURE command and monitor the temperature in the TEMPERATURE dialog box.
 - In CAM2 Q, run the DEVICES >DEVICE CONTROL PANEL command and click the TEMPERATURE button.
 - *For more information, see “Temperature” on page 114.*
- Do not calibrate probes during warm-up time.

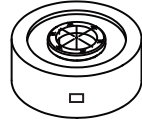


Mounting

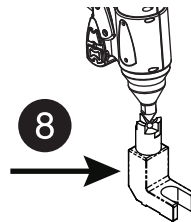
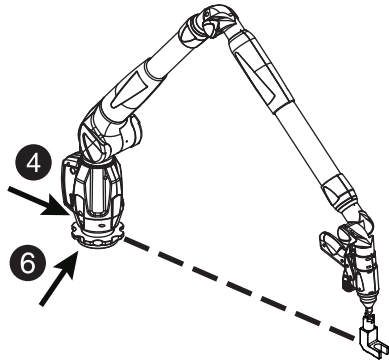
Most accuracy and repeatability problems can be attributed to improper mounting of the EDGE. These issues are not always obvious. An apparently stable mount can actually be moving more than the accuracy of the device, directly impacting results and causing system performance degradation.

- ❑ If using a magnetic mount, check that mating surfaces are clean and free of debris.

NOTE: Small metal shavings can cause the EDGE to rock back and forth. The magnet will naturally attract these shavings.



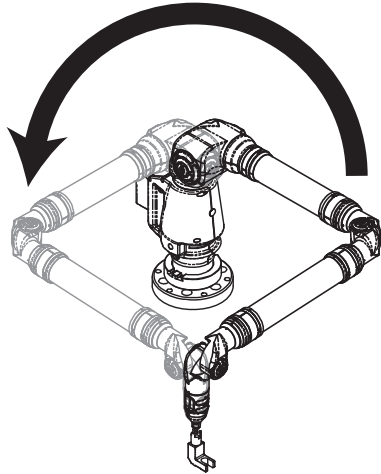
- 1 Line up front of EDGE base with the calibration cone.
- 2 Open up an X, Y, Z DRO in CAM2 or another application.
- 3 Place the probe in the cone and hold the EDGE very still.
- 4 Apply approximately five (5) pounds of force to the base ring in the direction of the cone.
- 5 Note the Y deviation. It should not exceed 25% of the EDGE's accuracy.
- 6 Apply approximately five (5) pounds of force to the base ring 90° away from the previous direction.
- 7 Note the Y deviation. It should not exceed 25% of the EDGE's accuracy.
- 8 Apply approximately five (5) pounds of force to the cone.
- 9 Note the X, Y and Z deviations. They should not exceed 25% of the EDGE's accuracy.



Single Point Articulation Test (SPAT)

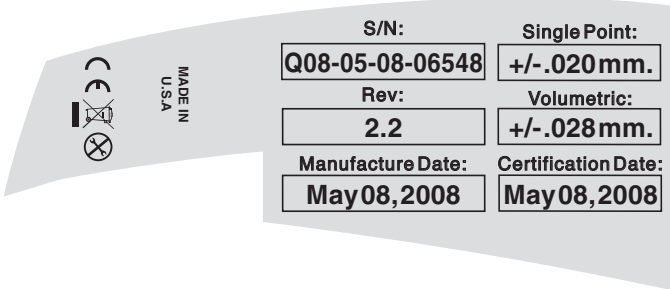
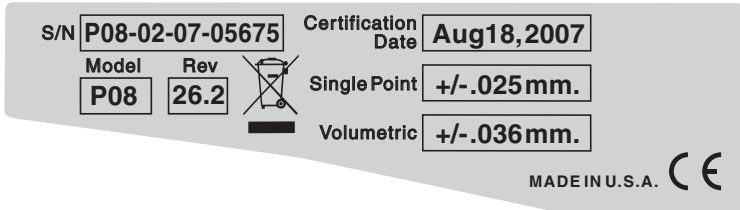
Mounting should always be tested prior to a SPAT test. The SPAT test checks the repeatability of the EDGE's X, Y and Z coordinates throughout its range of motion.

- ❑ In CAM2 software, start the SPAT routine from the DIAGNOSTICS dialog box.
 - In CAM2 Measure, run the DEVICES >DIAGNOSTICS command and click the SINGLE POINT ARTICULATION TEST (SPAT) button in the DIAGNOSTICS dialog box.
 - In CAM2 Q, run the DEVICES >DEVICE CONTROL PANEL command, click the DIAGNOSTICS button in the FARO DEVICE CONTROL PANEL. Then click the SINGLE POINT ARTICULATION TEST (SPAT) button in the DIAGNOSTICS dialog box.
 - *For more information, see “Diagnostics” on page 114.*
- ❑ Place and hold the calibrated probe in the calibration cone or any conical socket.
- ❑ Start with the elbow of the EDGE to one side and press the FRONT button.
- ❑ Slowly sweep the elbow so that it ends up on the opposite side.
NOTE: Measurements automatically record as the elbow moves.
 - In the dialog box, watch the status bar. Sweep the elbow all the way to the opposite side.
- ❑ Slowly sweep the elbow back to the starting side.
 - In the dialog box, watch the status bar. Sweep the elbow all the way back to the starting side.
- ❑ The SPAT automatically completes. The set of measurements from each sweep are compared for repeatability. If the sets are not repeatable, you must repeat the test.



NOTE: The EDGE movement should feel fluid. Be careful not to stress the EDGE while taking these points or get too close to an end stop since stresses can be amplified near end stops.

- ❑ Note the deviations in X, Y, and Z. The (Max-Min)/2, or Single Point repeatability value, of each coordinate should be lower than the value printed on the EDGE.



- ❑ Click the YES button to generate a detailed report of the test, or the NO button to end the test.

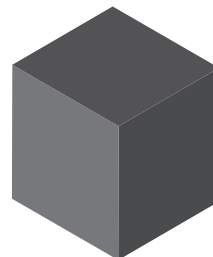
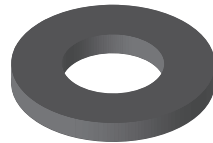
If not using CAM2, simply export your list of points to Microsoft Excel and calculate (Max.- Min.)/2 for each coordinate.

Calibrated Artifact

Measure an artifact of certified dimensions (i.e.: ring gage or gage block).

- ❑ Ring Gage should be measured as a cylinder.
- ❑ Gage Block should be measured plane-to-plane, or point-to-plane (surface point).

NOTE: The dimension of calibrated artifacts is usually specified at a temperature of 20°C (68°F). If the current temperature is different, use the Material Temperature Compensation function in CAM2, or the following formula:



Actual Length = Specified Length*(1 + CTE*(Current centigrade temperature - 20°C)), where CTE is the Coefficient of Thermal Expansion of the material in ppm/°C.

EXAMPLE: A 150mm ring gage measured at 25°C made of Steel 1020 will be: $150\text{mm} * (1 + 11.7\text{e-}6/\text{C}*(25^\circ\text{C} - 20^\circ\text{C})) = 150.00585 \text{ mm}$

If additional support is required, please contact customer support. When contacting FARO's Customer Service, please provide the following information:

- 1 The serial number of the device(s).
- 2 A copy of the probe calibration log.
- 3 A copy of the event log.
- 4 A copy of the Single Point Articulating Test (SPAT).
- 5 Pictures of the setup.

Diagnosing FARO Laser Line Probe Accuracy Problems

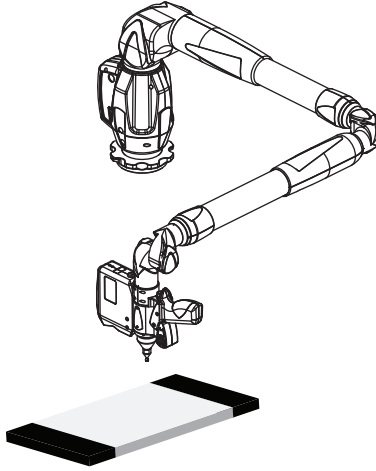
Always diagnose the EDGE prior to diagnosing the FARO Laser Line Probe. If the EDGE is not mounted correctly, or the hard probe is not accurately calibrated, then the FARO Laser Line Probe will produce inaccurate results.

Allow the FARO Laser Line Probe to warm-up.

- 60 minutes for version 1
- 30 minutes for version 2
- 15 minutes for version 3

Clean the top and bottom lenses with the cloth from the FARO Laser Line Probe Case. Dirt and grease on either lens can cause poor results.

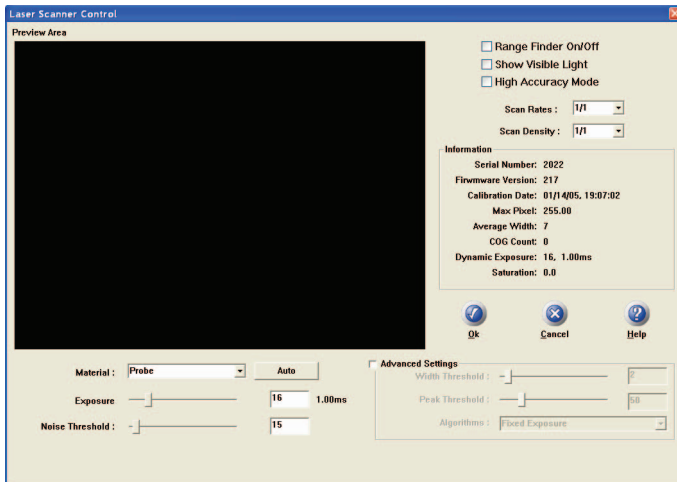
- Place the FARO Calibration Plate approximate 2/3 of the EDGE's reach away from its base.



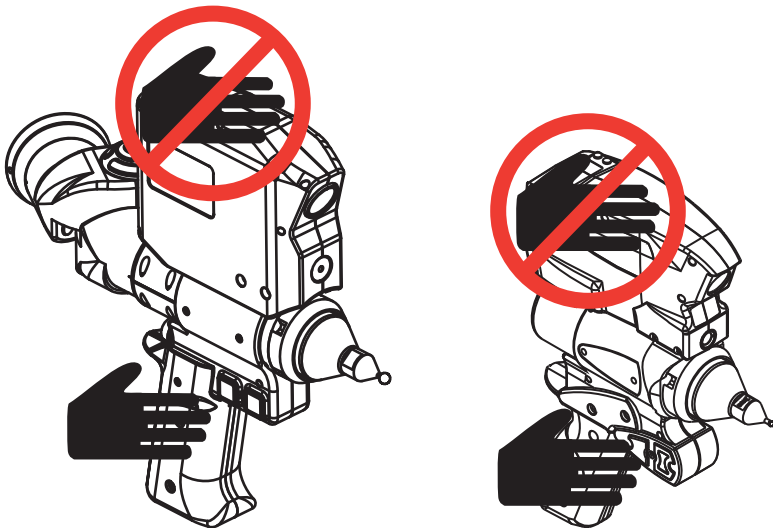
NOTE: Secure the plate firmly to the table. If you are clamping at more than one location, make sure that the surface is flat so that the plate does not bend. Clamping only on one end may create a “spring board” effect.

FARO Laser Line Probe Calibration

- Ensure the Scan Rate and Scan Density are set 1/1. From the host application select “Scanner Options” or “Scanner Controls” to access the settings dialog box.



- Perform the calibration at least 3 times. See “Calibration” on page 47.



NOTE: Never grab the FARO Laser Line Probe while measuring. Simply hold the EDGE's pistol grip. Holding the FARO Laser Line Probe can cause inaccuracy due to bending of its mounting bracket. When sweeping from side to side and front to back, make sure you sweep through at least 90 degrees.

Typically, you should take about 200 scans during the calibration process.

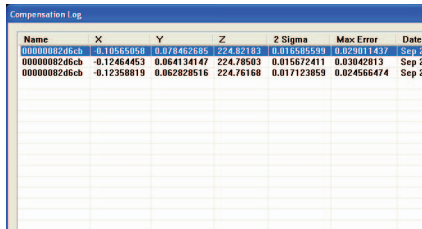
☐ In the probe calibration log, look at the X, Y, Z, A, B, C values. Each value should repeat to within:

X: 100 microns A: 0.1 degrees

Y: 50 microns B: 0.05 degrees

Z: 50 microns C: 0.1 degrees

NOTE: Values are for V2 FARO Laser Line Probe



Name	X	Y	Z	Z Sigma	Max Error	Date
0000002d6cb	0.10585059	0.278487695	224.821838	0.01585599	0.020119137	Sep 21
0000002d6cb	-0.12464453	0.064134147	224.785093	0.015672411	0.03042813	Sep 21
0000002d6cb	-0.12358819	0.062828516	224.761668	0.017123859	0.024566474	Sep 21

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- 1 The serial number of the device(s).
- 2 A copy of the probe calibration log.
- 3 A copy of the event log.
- 4 A copy of the Single Point Articulating Test (SPAT).
- 5 Pictures of the setup.

Chapter 2: Configuring the FaroArm® in CAM2® Measure

The DEVICES menu contains all the commands used to configure a measuring device. These commands are also available on the Devices toolbar.



Device Setup

Select DEVICES < DEVICE SETUP from the DEVICES menu. Choose a primary input device from the DEVICE SETUP dialog box. The default device is the FaroArm. To change the primary input device, select the device name and click the START button. This establishes communication with the selected device.

When the CAM2 Measure starts, the software attempts to initialize communication with the primary input device.

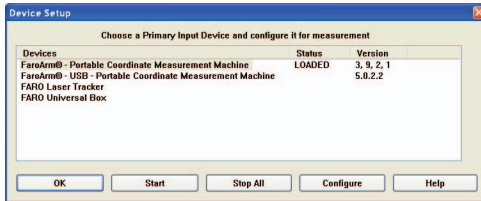


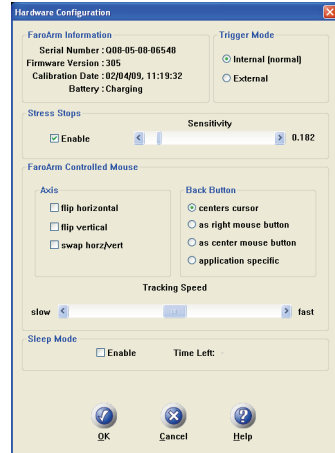
Figure 2-1 Device Setup dialog box



Hardware Configuration

Select DEVICES < HARDWARE CONFIG from the DEVICES menu. In the HARDWARE CONFIGURATION dialog box you can:

- View the current information about the FaroArm.
- Set the Trigger mode.
- Enable/disable Stress Stops and adjust the sensitivity. See “Error and Status Indicators” on page 16.
- Set the arm controlled mouse settings.
- Enable/disable Sleep Mode.



Click OK to accept the changes. Click the CANCEL button to discard any changes and exit the command.

Stress Stops: The default value is 0.182 and should rarely be set any lower.

NOTE: For FaroArm Advantage and FARO Digital Template set the stress stop sensitivity at a maximum of 0.364.

FaroArm Controlled Mouse: The movement of the mouse cursor can be switched as it relates to the movement of the probe.

Set an option for the device’s BACK button. These options are ignored during any measurement command.

- Application Specific - sends a special signal to the application software. The software can use this special signal to launch any command. For example, this repeats the last command in FARO’s CAM2 Measure X.

Tracking Speed: Adjust the speed of the cursor is adjusted using the Tracking Speed slider.

Sleep Mode: The FaroArm shuts down with no activity after two hours. TIME LEFT is the remaining time before the FaroArm shuts down.



Probes

Select **DEVICES < PROBES** from the **DEVICES** menu. In the **COMPENSATION** dialog box you can:

- Select the current probe and view the **COMPENSATION STATUS**.
- Create, Edit and Delete a probe.
- Compensate the current probe.
- View the compensation log for the current probe.
- Enable or disable the use of FARO i-Probes with the FaroArmQuantum.
- Start the Single Point Articulation Test (SPAT).
- Run a Arm Compensation or reset to the FARO Factory Arm Compensation.

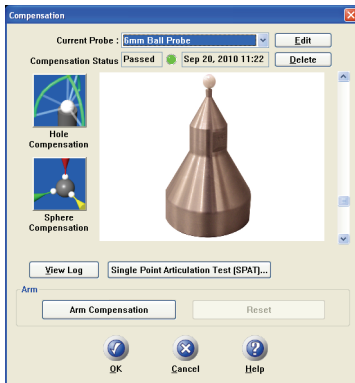


Figure 2-2 FaroArm Platinum/Fusion
Compensation dialog box

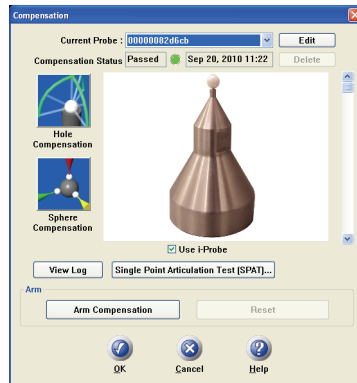


Figure 2-3 FaroArm Quantum
Compensation dialog box

The **COMPENSATION STATUS** and compensation date are displayed for every probe. The four standard probes for the FaroArm (3mm, 6mm, Point and FARO Laser Line Probe) are created by default. Compensate each of these probes before you begin measuring your parts.

Click the **PERFORM SINGLE POINT ARTICULATION TEST (SPAT)** button to run a Single Point Articulation Test (SPAT) with your FaroArm. You can save this report to a file which you can send to FARO's Customer Service Department. *For more information, see "Single Point Articulation Test (SPAT)" on page 73.*

Click the ARM COMPENSATION button to create a user arm compensation for your FaroArm. *For more information, see “User Compensation” on page 75.*

Using FARO i-Probes

When a FARO i-Probe is attached to a FaroArm Quantum, it is automatically added to the CURRENT PROBE list. You do not need to edit any parameters of the FARO i-Probe.

NOTE: FARO i-Probes will not attach to FaroArm Platinum or Fusion. Installing the i-Probe to anything other than a FaroArm Quantum damages the i-Probe.

Edit Probe

Click the EDIT button in the COMPENSATION dialog box to modify the details of the current probe. Change any settings and click the MODIFY button to continue.

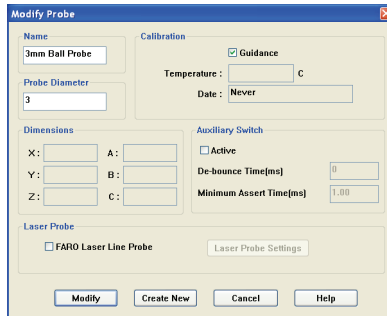


Figure 2-4 Modify Probe dialog box

To create a new probe:

- 1 Enter a new Name for the probe.
- 2 Enter the diameter of the probe. Check the status bar at the bottom of your screen for the current units.
- 3 Select the AUXILIARY SWITCH check box, and enter a De-bounce Time if necessary.
- 4 Select the GUIDANCE check box to use the guidance feature in hole compensation. See “Hole Method - Guidance” on page 86, and “Hole Method” on page 89.

5 Click the CREATE NEW button.

The new probe is now current. You *must* compensate the new probe.

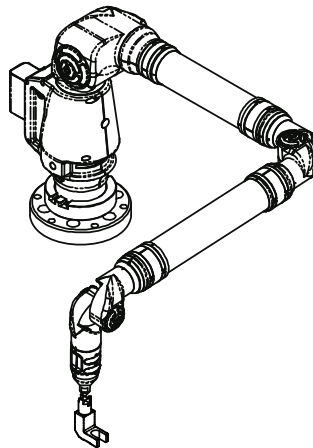
Probe Compensation Overview

Probe compensation is a localized process by which a measurement device is optimized to perform measurements accurately.

To understand probe compensation, you must first understand the FaroArm's reference system. The FaroArm is factory compensated from the base to the last joint or axis, and the position of this joint is defined by the coordinate system which originates at the base of the FaroArm. The last axis of the FaroArm has its own coordinate system, and the location of the center of the ball probe is reported in the probe's coordinate system. After the probe's coordinates are established, these are translated into FaroArm coordinates and you are ready to start taking measurements.

Measurement accuracy relies on probe compensation under optimal conditions. If the probe compensation passes, measurements will be accurate. If the probe compensation fails, measurements will not be as accurate. Proper mounting and technique are critical compensation factors.

To optimize compensation and minimize stress-induced errors during this critical procedure, place the FaroArm in a single position in which the elbow joint remains relatively stationary without any obstructions or restrictions in movement while the compensation is performed. Do not let the elbow joint fall during compensation. Only exercise the last joint of the FaroArm for the software to accurately compensate the probe tip. Minimizing elbow joint movement and focusing on the probe and last arm joint during compensation maximizes measurement accuracy.



Compensate Probe

When changing the style or dimension of the probe at the end of the FaroArm, you must compensate it for the FaroArm to measure and function accurately. Probe compensation is an optimization procedure that requires you to digitize points. The two methods of compensation are:

- Hole 

- Sphere 

Click either button to compensate the current probe. The Hole Compensation method differs depending on whether the GUIDANCE check box is selected or cleared. See “*Edit Probe*” on page 84.

- See “*Hole Method - Guidance*” on page 86.
- See “*Hole Method*” on page 89.
- See “*Sphere Method*” on page 91.



Hole Method - Guidance

Perform the Hole compensation using the FARO probe compensation cone. If the GUIDANCE check box is selected for the current probe, use the following steps. See “*Edit Probe*” on page 84.

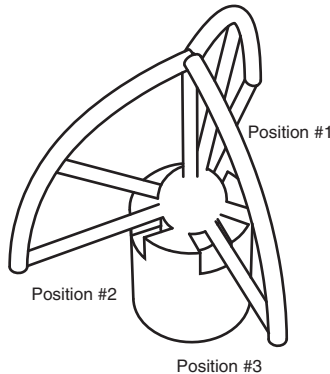
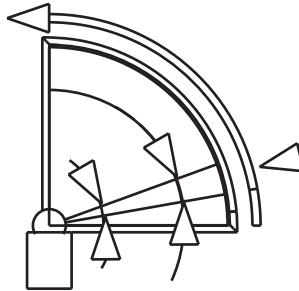


Figure 2-5 Hole Method

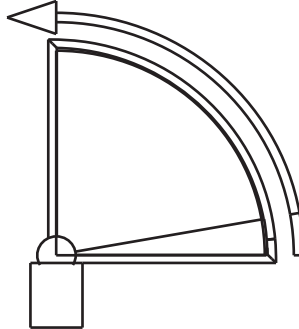
Collect all of the points in this method by holding down the FRONT button. The FaroArm will collect points as fast as possible (“scanning”)

until you release the FRONT button. Digitize at least 200 points in each of the three different positions.

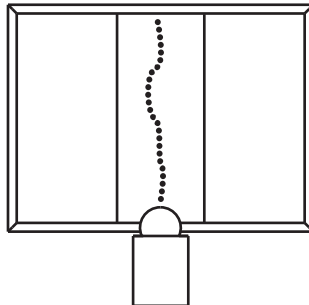
- 1 Place the ball probe in the cone.
- 2 Seat the probe in the cone, move the handle down until the shaft of the probe is parallel with the top of the cone.



- Look at the dialog box and move the handle until you reach the starting position.

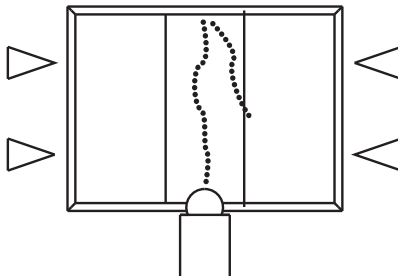


- 3 Press and hold the FRONT button. Sweep the handle up to the vertical position, making sure to move in a straight line. Be sure that the ball probe remains seated in the hole.



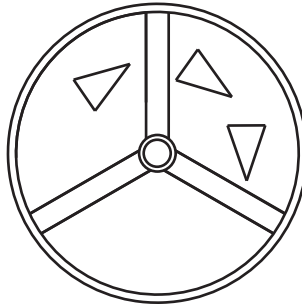
- Release the FRONT button to pause.
- Look at the dialog box to help you stay within the zone.

- 4 Sweep again until all 200 points are digitized. Look at the dialog box to help you digitize all of the points.



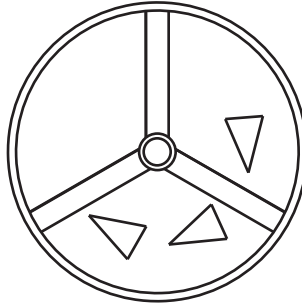
5 Rotate the Probe to the next position. Look at the dialog box and move the handle until you reach the start of the next position.

- Repeat steps 1 through 4 and digitize 200 more points in this position.



6 Rotate the Probe to the last position. Look at the dialog box and move the handle until you reach the start of the next position.

- Repeat steps 1 through 4 and digitize 200 more points in this position.



NOTE: Seven-axis FaroArms have an additional position. Rotate the handle.

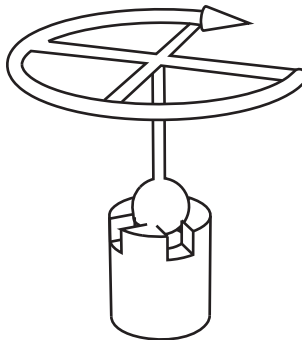
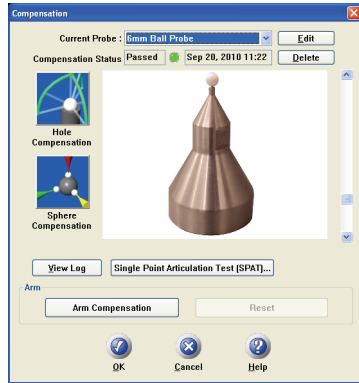


Figure 2-6 Additional Position for Seven-axis FaroArms

CAUTION: The probe *must* be well-seated in the hole when digitizing all compensation points. Even one or two poorly digitized points significantly affects the optimization process, which then has an effect on the accuracy of the FaroArm.

The digitized compensation points then calculate and the COMPENSATION STATUS updates. If the probe passes, the current date and time is added to the probe information.

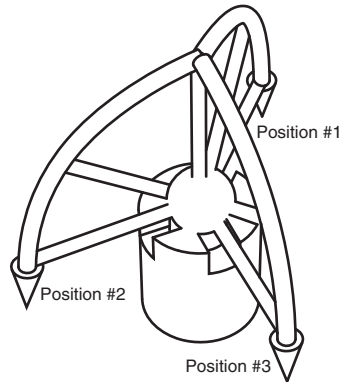
You can view the details for all of the compensations of a probe by clicking the VIEW LOG button. See “View Log” on page 95.



Hole Method

Perform the Hole compensation using the FARO probe compensation cone or a 5mm diameter machine drilled hole. The hole does not have to be exactly 5mm, but it must be smaller than the probe’s diameter with a smooth seat. If the GUIDANCE check box is clear for the current probe, use the following steps. See “Edit Probe” on page 84.

Collect all of the points in this method by holding down the FRONT button. The FaroArm will collect points as fast as possible (“scanning”) until you release the FRONT button.



- 1 Place the ball probe in the hole. Start in a vertical position.
- 2 Press and hold the FRONT button. Sweep the handle down to one of the horizontal positions. Be sure that the ball probe remains seated in the hole.
- 3 Release the FRONT button and repeat for each position.

- Digitize points in the hole and sweep to position #1.
- Digitize points in the hole and sweep to position #2.
- Digitize points in the hole and sweep to position #3.

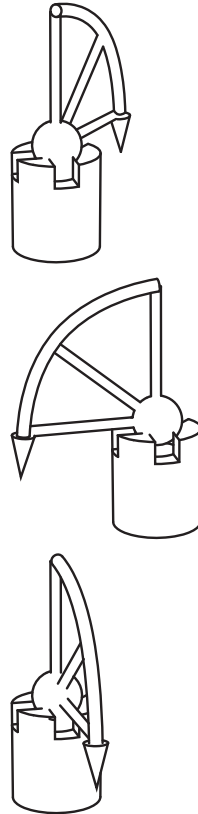


Figure 2-7 Hole Method - Guidance

NOTE: Seven-axis FaroArms have an additional position. Rotate the handle.

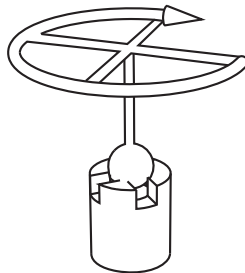


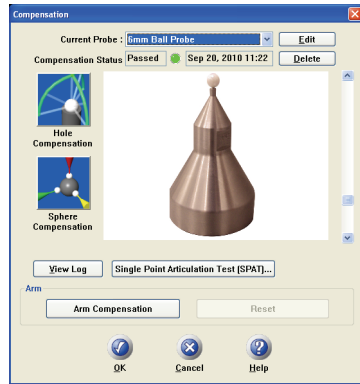
Figure 2-8 Additional Position for Seven-axis FaroArms

CAUTION: The probe *must* be well-seated in the hole when digitizing all compensation points. Even one or two poorly digitized

points significantly affects the optimization process, which then has an effect on the accuracy of the FaroArm.

The digitized compensation points then calculate and the COMPENSATION STATUS updates. If the probe passes, the current date and time is added to the probe information.

You can view the details for all of the compensations of a probe by clicking the View Log button. See “View Log” on page 95.



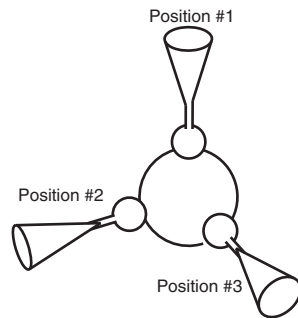
Sphere Method

Perform the Sphere compensation using any size precision sphere or tooling ball. The sphere should be at least 10mm (3/8”) diameter or larger. The Sphere compensation method differs slightly for Six-Axis FaroArms or Seven-Axis FaroArms. See “Six-Axis FaroArm” on page 91 or “Seven-Axis FaroArm” on page 93.

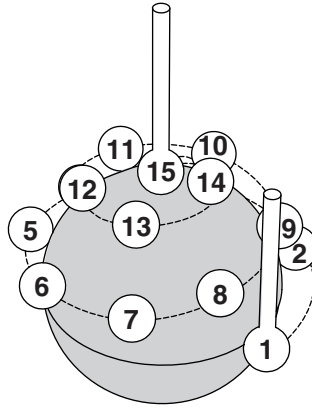
Six-Axis FaroArm

You will digitize 45 individual points in specific locations around the sphere by pressing the FRONT button for each.

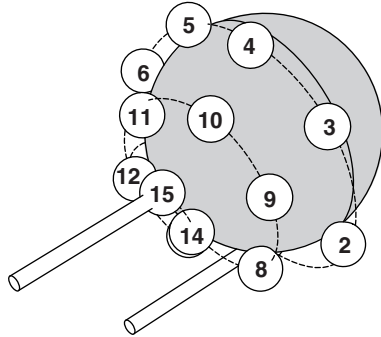
CAUTION: The ball probe *must* remain in contact with the sphere while digitizing points. Even one or two poorly digitized points significantly affects the optimization process, which then has an effect on the accuracy of the FaroArm.



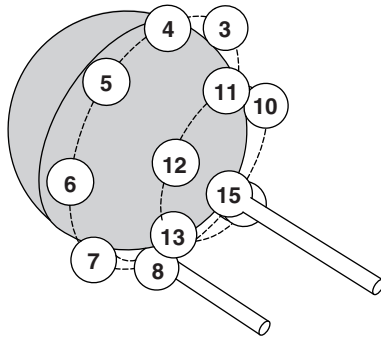
- Digitize 15 points around the top hemisphere of the sphere with the probe pointing in position #1.



- Digitize 15 points around the front hemisphere of the sphere with the probe pointing in position #2.

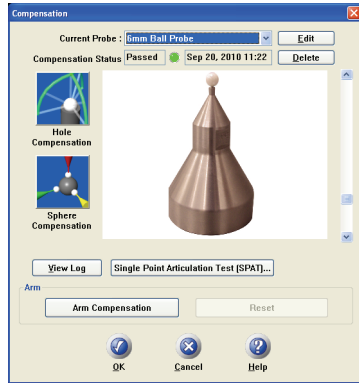


- Digitize 15 points around the side hemisphere of the sphere with the probe pointing in position #3.



The digitized compensation points then calculate and the COMPENSATION STATUS updates. If the probe passes, the current date and time is added to the probe information.

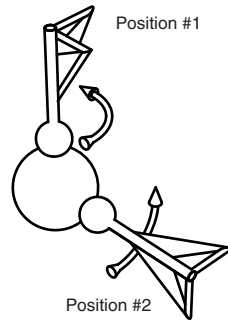
You can view the details for all of the compensations of a probe by clicking the View Log button. See “View Log” on page 95.



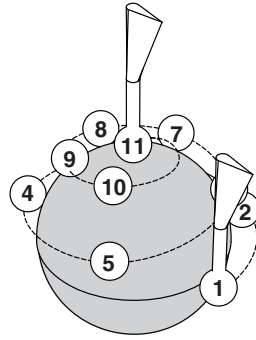
Seven-Axis FaroArm

You will digitize 44 individual points in specific locations around the sphere by pressing the FRONT button for each.

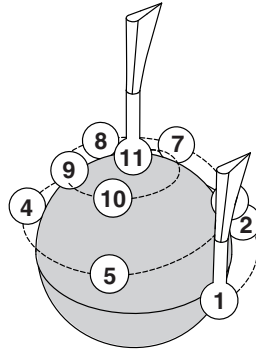
CAUTION: The ball probe *must* remain in contact with the sphere while digitizing points. Even one or two poorly digitized points significantly affects the optimization process, which then has an effect on the accuracy of the FaroArm.



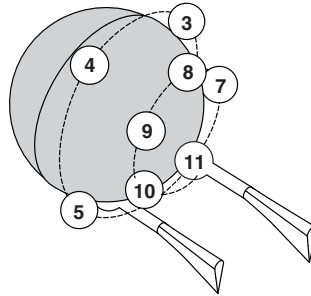
- Digitize 11 points around the top hemisphere of the sphere with the probe pointing in position #1. Hold the handle in the same direction and orientation for every point.



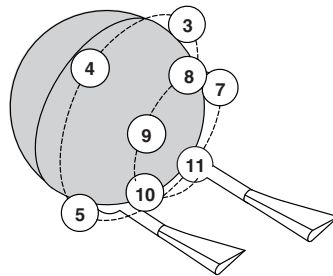
- Rotate the handle 90 degrees. Digitize 11 points around the top hemisphere of the sphere with the probe pointing in position #1. Hold the handle in the same direction and orientation for every point.



- Digitize 11 points around the front hemisphere of the sphere with the probe pointing in position #2. Hold the handle in the same direction and orientation for every point.

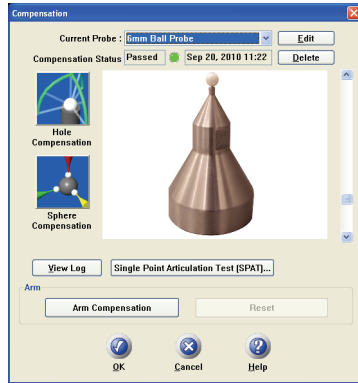


- Rotate probe 90 degrees. Digitize 11 points around the front hemisphere of the sphere with the probe pointing in position #2. Hold the handle in the same direction and orientation for every point.



The digitized compensation points then calculate and the COMPENSATION STATUS updates. If the probe passes, the current date and time is added to the probe information.

You can view the details for all of the compensations of a probe by clicking the View Log button. See “View Log” on page 95.



View Log

The COMPENSATION LOG dialog box displays the compensation history of the current probe. You can set to active or delete any previous compensation. You can also select the compensation values and copy them to the windows clipboard.

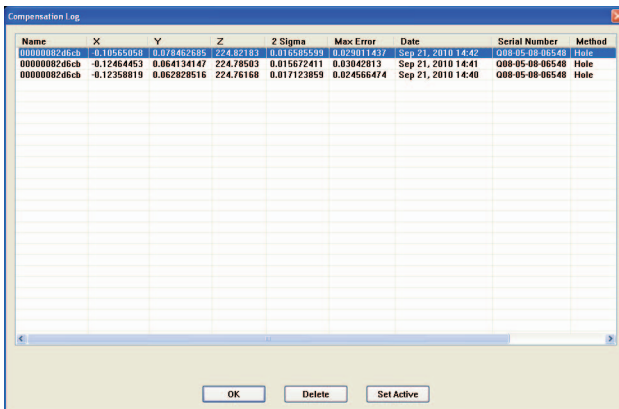


Figure 2-9 Compensation Log dialog box

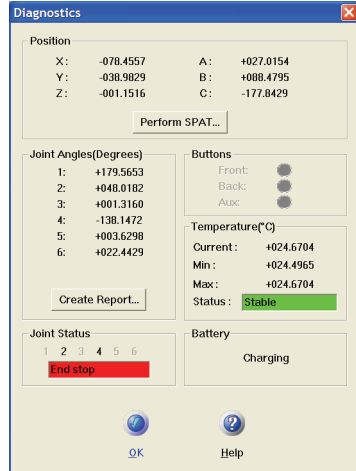
- The X, Y, Z values are the location of the center of the ball probe in the last joint coordinate system.
- The 2 Sigma value is the deviation of all the points taken during the compensation.
- The Max. Error column displays the displacement of the point with the largest displacement. In order to pass compensation, this value has to be less than the single point accuracy specification of the arm. See “FaroArm Performance” on page 51.



Diagnostics

Select DEVICES < DIAGNOSTICS from the DEVICES menu. The DIAGNOSTICS dialog box displays:

- X, Y, Z Machine Coordinates.
- Encoder angles for each joint of the FaroArm.
- FRONT and BACK button, and Auxiliary Port operations.
- The Temperature of the FaroArm's internal sensor.
- The Joint Status of each joint of the FaroArm which also includes the encoder end stop warnings.
- The status of the FaroArm battery.



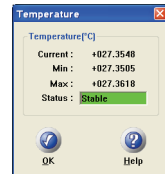
Click the PERFORM SINGLE POINT ARTICULATION TEST (SPAT) button to run a Single Point Articulation Test (SPAT) with your FaroArm. You can save this report to a file which you can send to FARO's Customer Service Department. *For more information, see "Single Point Articulation Test (SPAT)" on page 73.*



Temperature

Select DEVICES < TEMPERATURE from the DEVICES menu. This command displays the current temperature of the FaroArm and the elapsed time of the temperature sampling.

Because different components heat up or cool down at different rates, the FaroArm must be at a steady state temperature (within $\pm 3^{\circ}$ Celsius for five minutes) before measuring with the device.



Chapter 3: Configuring the FaroArm® in CAM2® Q

The DEVICE CONTROL panel contains all the commands for configuring a measuring device. In CAM2 Q choose DEVICE < DEVICE CONTROL PANEL to show the panel. You can also press the **P** hot key on the keyboard.



Device Control Panel

The DEVICE CONTROL panel appears when CAM2 Q is launched, and contains a list of all active (detected) devices. The DEVICE CONTROL panel contains a list of all active devices with the properties of each associated device. You can also press the P hot key on the keyboard.

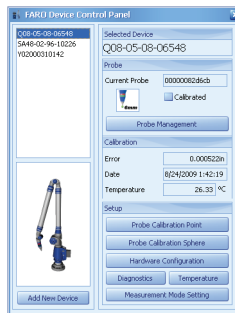


Figure 3-1 Device Control Panel

Choose a FaroArm from the list to see the probe details.

- Click the >> button to hide the list of devices.
- Click the << button to show the list of devices.

Add a Device

From the DEVICE CONTROL panel, click the ADD NEW DEVICE button. Select an eligible device from the ADD NEW DEVICE dialog and click CONNECT.

Change Probe

From the DEVICE CONTROL panel, click the PROBE MANAGEMENT button to show the COMPENSATION dialog box. *For more information, see “Probes” on page 83.*

Hole Compensation

From the DEVICE CONTROL panel, click the PROBE COMPENSATION POINT button to compensate the probe. *For more information, see “Hole Method” on page 89.*

Sphere Compensation

From the DEVICE CONTROL panel, click the PROBE COMPENSATION SPHERE button to compensate the probe. *For more information, see “Sphere Method” on page 91.*

Hardware Configuration

From the DEVICE CONTROL panel, click the HARDWARE CONFIGURATION button to change the setup of the FaroArm. *For more information, see “Hardware Configuration” on page 82.*

Diagnostics

From the DEVICE CONTROL panel, click the DIAGNOSTICS button to show the FaroArm DIAGNOSTICS dialog box. *For more information, see “Diagnostics” on page 96.*

Temperature

From the DEVICE CONTROL panel, click the TEMPERATURE button to show the TEMPERATURE dialog box. *For more information, see “Temperature” on page 96.*

Measurement Mode Setting

From the DEVICE CONTROL panel, click the MEASUREMENT MODE SETTING button to set the default collection mode in the MODE drop-down window of the MEASUREMENT WINDOW for this device.

NOTE: The MEASUREMENT WINDOW appears when the CAM2 Q ADD READINGS command is started, or when any measure feature command is started in MEASURE NOW mode.

In the MODE SETTINGS dialog:

- *Single Point:* press the FRONT button, or the G key, to collect a single reading.
- *Distance Interval:* press the FRONT button, or the G key, to start the distance interval. Collect a single reading when the probe moves a distance. Choose this radio button, enter the distance value and press OK.
- *Time Interval:* press the FRONT button, or the G key, to start the time interval. Collect a single reading over time. Choose this radio button, enter the time value and press OK.

Technical Support

FARO Technologies, Inc. is committed to providing the best technical support to our customers. Our Service Policy is detailed in *Appendix C: Industrial Products Service Policy* of this manual. If you have any problem using one of our products, please follow these steps before contacting our Technical Support Team:

- Be sure to read the relevant sections of the documentation to find the help you need.
- Visit the FARO Customer Care area on the Web at www.faro.com to search our technical support database. This is available 24 hours a day 7 days a week.
- Document the problem you are experiencing. Be as specific as you can. The more information you have, the easier the problem will be to solve.
- If you still cannot resolve your problem, have your device's Serial Number available *before calling*.

Support Hours (Monday through Friday)

North America:

8:00 a.m. to 8:00 p.m. Eastern Standard Time (EST).

Europe:

8:00 a.m. to 5:00 p.m. Central European Standard Time (CET).

Asia:

8:30 a.m. to 5:30 p.m. Singapore Standard Time (SST).

Japan:

9:00 a.m. to 5:00 p.m. Japan Standard Time (JST).

China:

8:30 a.m. to 5:30 p.m. China Standard Time (CST).

India:

9:30 a.m. to 5:30 p.m. India Standard Time (IST).

You can also e-mail or fax any problems or questions 24 hours a day.

• **Phone**

North America:

800 736 2771, +1 407 333 3182 (Worldwide)

Europe:

+800 3276 7378, +49 7150 9797-400 (Worldwide)

Asia:

1800 511 1360, +65 6511 1350 (Worldwide)

Japan:

+800 6511 1360, +81 561 63 1411 (Worldwide)

China:

+800 6511 1360, +86 21 6191 7600 (Worldwide)

India:

000800 650 1397, +91 11 4167 6330/1 (Worldwide)

- **Fax**

North America:

+1 407 333 8056

Europe:

+800 3276 1737, +49 7150 9797-9400 (Worldwide)

Asia:

+65 6543 0111

Japan:

+81 561 63 1412

China:

+86 21 6494 8670

India:

+91 11 4167 6332

- **E-Mail**

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support_japan@faro.com

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chinainfo@faro.com

India:

infoindia@faro.com

E-Mails or Faxes sent outside regular working hours usually are answered before 12:00 p.m. the next working day. Should our staff be on other calls, please leave a voice mail message; calls are always returned within 4 hours. Please remember to leave a detailed description of your question and your device's Serial Number. Do not forget to include your name, fax number, telephone number and extension so we can reach you promptly.

Appendix A: Software License Agreement

This Software License Agreement is part of the Operating Manual for the product and software System which you have purchased from FARO TECHNOLOGIES, INC. (collectively, the “Licensor”) By your use of the software you are agreeing to the terms and conditions of this Software License Agreement. Throughout this Software License Agreement, the term “Licensee” means the owner of the System.

I. The Licensor hereby grants the Licensee the non-exclusive right to use the computer software described in this Operating Manual (the “software”). The Licensee shall have no right to sell, assign, sub-license, rent or lease the software to any third party without the Licensor’s prior written consent.

II. The Licensor further grants the Licensee the right to make a backup copy of the software media. The Licensee agrees that it will not decompile, disassemble, reverse engineer, copy, transfer, or otherwise use the software except as permitted by this section. The Licensee further agrees not to copy any written materials accompanying the software.

III. The Licensee is licensed to use the Software only in the manner described in the Operating Manual. Use of the Software in a manner other than that described in the Operating Manual or use of the software in conjunction with any non-Licensor product which decompiles or recompiles the software or in any other way modifies the structure, sequence or function of the software code, is not an authorized use, and further, such use voids the Licensor’s set forth below.

IV. The only warranty with respect to the software and the accompanying written materials is the warranty, if any, set forth in the Quotation/Purchase Order and *Appendix B: Purchase Conditions* pursuant to which the software was purchased from the Licensor.

V. THIS WARRANTY IS IN LIEU OF OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE SOFTWARE AND WRITTEN MATERIALS. IN NO EVENT

WILL THE LICENSER BE LIABLE FOR DAMAGES, INCLUDING ANY LOST PROFITS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE SOFTWARE, NOTWITHSTANDING THAT THE LICENSER HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, THE LICENSER WILL NOT BE LIABLE FOR ANY SUCH CLAIM BY ANY OTHER PARTY.

VI. In the event of any breach by the Licensee of this Agreement, the license granted hereby shall immediately terminate and the Licensee shall return the software media and all written materials, together with any copy of such media or materials, and the Licensee shall keep no copies of such items.

VII. The interpretation of this Agreement shall be governed by the following provisions:

A. This Agreement shall be construed pursuant to and governed by the substantive laws of the State of Florida (and any provision of Florida law shall not apply if the law of a state or jurisdiction other than Florida would otherwise apply).

B. If any provision of this Agreement is determined by a court of competent jurisdiction to be void and non-enforceable, such determination shall not affect any other provision of this Agreement, and the remaining provisions of this Agreement shall remain in full force and effect. If any provision or term of this Agreement is susceptible to two or more constructions or interpretations, one or more of which would render the provision or term void or non-enforceable, the parties agree that a construction or interpretation which renders the term of provision valid shall be favored.

C. This Agreement constitutes the entire Agreement, and supersedes all prior agreements and understandings, oral and written, among the parties to this Agreement with respect to the subject matter hereof.

VIII. If a party engages the services of an attorney or any other third party or in any way initiates legal action to enforce its rights under this Agreement, the prevailing party shall be entitled to recover all reasonable costs and expenses (including reasonable attorney's fees before trial and in appellate proceedings).

Appendix B: Purchase Conditions

All Purchase Orders (hereafter, the “Order”) for FARO-provided products and services (hereafter, the “Product”) are subject to the following terms and conditions, which are agreed to by the Purchaser. All capitalized terms are defined in Section 8.00 Definitions hereafter.

1.00 Payment of Purchase Price

1.01 Purchaser hereby promises to pay to the order of FARO all deferred portions of the Purchase Price, together with interest on late purchase price payments payable at 1.5% per month (18% per annum).

1.02 The Purchaser grants to FARO a security interest in the products sold pursuant to the Order, which may be perfected by UCC-1 Financing Statements to be recorded in the applicable County of the Purchaser’s business location and filed with the Secretary of State’s Office, which security interest will remain in effect until payment in full of the purchase price together with interest on late purchase price payments payable thereon had been received by FARO.

1.03 If the Purchaser fails to make full payment of the purchase price within the period set out in the Order, FARO shall at its option have the following remedies, which shall be cumulative and not alternative:

- a) the right to cancel the Order and enter the Purchaser’s premises to re-take possession of the Product, in which event the Purchaser agrees that any down-payment or deposit shall be forfeited to FARO, as liquidated damages and not as a penalty, and all costs incurred by FARO in connection with the removal and subsequent transportation of the Product shall be payable by the Purchaser upon written demand;
- b) the right to enter the Purchaser’s premises and remove any Software, components of the Product or other items necessary in order to render the Product inoperative;
- c) the right to withhold all services which would otherwise be required to be provided by FARO pursuant to the Warranties set out in Section 4.00 Warranties and Limitation of Liability hereof;
- d) terminate any existing software license agreement and

e) pursue any other available remedy, including suing to collect any remaining balance of the purchase price (i.e., accelerate the payment of the purchase price causing the entire balance to immediately become due and payable in full).

f) Customer will be charged a 20% restocking fee for refusal to accept equipment as delivered. Equipment must be returned unopened within 10 business days of receipt at customer facility.

1.04 If Purchaser fails to make payment(s) in accordance with the terms of this Order, the Purchaser's Products may be rendered inoperable until such payment terms are met.

No waiver by FARO of its rights under these conditions shall be deemed to constitute a waiver of subsequent breaches or defaults by the Purchaser. In the event more than one Product is being purchased pursuant to the Order, unless otherwise set forth herein, each payment received by FARO from Purchaser shall be applied pro rata against the cost of each product rather than being applied to the purchase price of any product.

2.00 Delivery and Transportation

2.01 Delivery dates are estimates and not guarantees, and are based upon conditions at the time such estimate is given.

2.02 FARO shall not be liable for any loss or damage, whether direct, indirect or consequential, resulting from late delivery of the Product. The Purchaser's sole remedy, if the Product is not delivered within 90 days of the estimated delivery date, shall be to cancel the Order and to recover from FARO without interest or penalty, the amount of the down-payment or deposit and any other part of the purchase price which has been paid by the Purchaser. Notwithstanding the foregoing, such right of cancellation shall not extend to situations where late delivery is occasioned by causes beyond FARO's control, including, without limitation, compliance with any rules, regulations, orders or instructions of any federal, state, county, municipal or other government or any department or agency thereof, force majeure, acts or omissions of the Purchaser, acts of civil or military authorities, embargoes, war or insurrection, labor interruption through strike or walkout, transportation delays and other inability resulting from causes beyond FARO's control to obtain necessary labor, manufacturing facilities or materials from its usual sources. Any delays resulting from such causes shall extend estimated delivery dates by the length of such delay.

2.03 Responsibility for all costs and risks in any way connected with the storage, transportation and installation of the Product shall be borne entirely by the Purchaser. If any disagreement arises as to whether or not damage to the Product was in fact caused in storage, transit or on installation, the opinion of FARO's technical advisors, acting reasonably, shall be conclusive.

3.00 Installation and Operator Training

3.01 The Purchaser shall be responsible for installation of the Product, including, without limitation, the preparation of its premises, the uncrating of the Product and setting up of the Product for operation. Purchaser may elect to order contract services from FARO to perform this service should they elect to do so.

4.00 Warranties and Limitation of Liability

4.01 FARO warrants that (subject to Section 4.06), the Product shall be free from defects in workmanship or material affecting the fitness of the Product for its usual purpose under normal conditions of use, service and maintenance. A complete statement of FARO's maintenance/warranty service is set forth in *Appendix B: Purchase Conditions*.

4.02 FARO warrants that the Software shall operate according to specifications and the System shall operate and perform in the manner contemplated in connection with the usual purpose for which it is designed.

4.03 The maintenance/warranty set out in paragraphs 4.01 shall expire at the end of the twelve (12) month period commencing on the date of shipment from the FARO factory (the "Maintenance/Warranty Period").

4.04 Subject to the limitations contained in Section 4.06, the Warranties shall apply to any defects found by the Purchaser in the operation of the FaroArm and reported to FARO within the Maintenance/Warranty Period. If the FaroArm or the Software is found by FARO, acting reasonably, to be defective, and if the defect is acknowledged by FARO to be the result of FARO's faulty material or workmanship, the FaroArm will be repaired or adjusted to the extent found by FARO to be necessary or at the option of FARO, replaced with a new FaroArm or parts thereof at no cost to the Purchaser.

4.05 Claims under the Warranties shall be made by delivering written notice to FARO of the defect in the System, the FaroArm. Within a

reasonable time of receipt of such notice, FARO shall have the System and FaroArm diagnosed by its service personnel, and maintenance/warranty service will be provided at no cost to the Purchaser if the System and FaroArm is found by FARO to be defective within the meaning of this Section.

(If, in the reasonable opinion of FARO after diagnosis of the system and the FaroArm are not defective, the Purchaser shall pay the cost of service, which shall be the amount that FARO would otherwise charge for an evaluation under a non-warranty service evaluation.

4.06 The Warranties do not apply to:

- a) Any defects in any component of a System where, if in the reasonable opinion of FARO, the FaroArm, Software or System has been improperly stored, installed, operated, or maintained, or if Purchaser has permitted unauthorized modifications, additions, adjustments and/or repair to any hard drive structure or content, or any other part of the System, or which might affect the System, or defects caused or repairs required as a result of causes external to FARO workmanship or the materials used by FARO. As used herein, "unauthorized" means that which has not been approved and permitted by FARO.
- b) The Warranties shall not cover replacement of expendable items, including, but not limited to, fuses, diskettes, printer paper, printer ink, printing heads, disk cleaning materials, or similar items.
- c) The Warranties shall not cover minor preventive and corrective maintenance, including, but not limited to, replacement of fuses, disk drive head cleaning, fan filter cleaning and system clock battery replacement.
- d) Any equipment or its components which was sold or transferred to any party other than the original Purchaser without the expressed written consent of FARO.

4.07 Factory Repairs

- a) IF SYSTEM IS UNDER MAINTANENCE/WARRANTY: The Purchaser agrees to ship the Product to FARO in the original packing containers. FARO will return the repaired or replacement Product. FARO will incur the expense of the needed part and all return

shipping charges to the Purchaser. FARO may authorize the manufacturer of a component of the Product to perform the service.

b) IF SYSTEM IS UNDER PREMIUM SERVICE PLAN: When practical and subject to availability, FARO will make available to the Purchaser substitute component parts or FaroArm's ("Temporary Replacements") while corresponding parts of the Purchaser's system or FaroArm are undergoing repair at FARO's factory. Shipping charges for these "Temporary Replacement" parts or FaroArm's will be the responsibility of FARO.

c) IF SYSTEM IS NOT UNDER MAINTANENCE/WARRANTY: The Purchaser is responsible for the cost of the replacement part or software, and all shipping charges. All charges shall be estimated and prepaid prior to commencement of repairs.

4.08 Nothing herein contained shall be construed as obligating FARO to make service, parts, or repairs for any product available after the expiration of the Maintenance/Warranty Period.

4.09 Limitation of Liability

FARO shall not be responsible under any circumstances for special, incidental or consequential damages, including, but not limited to, injury to or death of any operator or other person, damage or loss resulting from inability to use the System, increased operating costs, loss of production, loss of anticipated profits, damage to property, or other special, incidental or consequential damages of any nature arising from any cause whatsoever whether based in contract, tort (including negligence), or any other theory of law. FARO's only liability hereunder, arising from any cause whatsoever, whether based in contract, tort (including negligence) or any other theory of law, consists of the obligation to repair or replace defective components in the System or FaroArm subject to the limitations set out above in this section.

This disclaimer of liability for consequential damage extends to any such special, incidental or consequential damages which may be suffered by third parties, either caused directly or indirectly resulting from test results or data produced by the system or any component thereof and the Purchaser agrees to indemnify and save FARO harmless from any such claims made by third parties.

4.10 The foregoing shall be FARO's sole and exclusive liability and the Purchaser's sole and exclusive remedy with respect to the system.

THE SOLE RESPONSIBILITY OF FARO UNDER THE WARRANTIES IS STATED HEREIN AND FARO SHALL NOT BE LIABLE FOR CONSEQUENTIAL, INDIRECT, OR INCIDENTAL DAMAGES, WHETHER THE CLAIM IS FOR BREACH OF WARRANTY, NEGLIGENCE, OR OTHERWISE.

OTHER THAN THE EXPRESS WARRANTIES HEREIN STATED, FARO DISCLAIMS ALL WARRANTIES INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

4.11 FARO does not authorize any person (whether natural or corporate) to assume for FARO any liability in connection with or with respect to the Products. No agent or employee of FARO has any authority to make any representation or promise on behalf of FARO, except as expressly set forth herein, or to modify the terms or limitations of the Warranties. Verbal statements are not binding upon FARO.

4.12 The Maintenance/Warranties extend only to the Purchaser and are transferable, only under the following conditions:

- The FaroArm is currently under maintenance/warranty.
- New owner is, or becomes, a certified user.
- A FARO maintenance/warranty transfer form is completed, and submitted to Customer Service.

All claims under the Warranties must originate with the Purchaser, or any subsequent owner, and the Purchaser will indemnify and save FARO harmless from any claims for breach of warranty asserted against FARO by any third party.

4.13 Oral representations of FARO or its sales representatives, officers, employees or agents cannot be relied upon as correctly stating the representations of FARO in connection with the system. Refer to this purchase order, any exhibits hereto and any written materials supplied by FARO for correct representations.

4.14 PURCHASER ACKNOWLEDGES THAT IT HAS PURCHASED THE SYSTEM BASED UPON ITS OWN KNOWLEDGE OF THE USES TO WHICH THE SYSTEM WILL BE PUT. FARO

SPECIFICALLY DISCLAIMS ANY WARRANTY OR LIABILITY RELATED TO THE FITNESS OF THE SYSTEM FOR ANY PARTICULAR PURPOSE OR ARISING FROM THE INABILITY OF THE PURCHASER TO USE THE SYSTEM FOR ANY PARTICULAR PURPOSE.

5.00 Design Changes

5.01 The FaroArm, the Software and the System are subject to changes in design, manufacture and programming between the date of order and the actual delivery date. FARO reserves the right to implement such changes without the Purchaser's consent, however, nothing contained herein shall be construed as obligating FARO to include such changes in the FaroArm, Software or System provided to the Purchaser.

6.00 Non-Disclosure

6.01 All Software including, without limitation, the Operating System Program and any FARO special user programs, provided to the Purchaser as part of the system, either at the time of or subsequent to the delivery of the FaroArm, is the intellectual property of FARO. The Purchaser shall not reproduce or duplicate, disassemble, decompile, reverse engineer, sell, transfer or assign, in any manner the Software or permit access to or use thereof by any third party. The Purchaser shall forthwith execute any further assurances in the form of non-disclosure or licensing agreements which may reasonably be required by FARO in connection with the software.

7.00 Entire Agreement / Governing Law / Miscellaneous / Guarantee

7.01 These Purchase conditions constitute the entire agreement between FARO and the Purchaser in respect to the Product. There are no representations or warranties by FARO, express or implied, except for those herein contained and these conditions supersede and replace any prior agreements between FARO and the Purchaser.

7.02 No representative of FARO has any authority to modify, alter, delete or add to any of the terms or conditions hereof. Any such modifications shall be absolutely void unless made by instrument in writing properly executed by an actual authorized employee or agent of FARO.

7.03 The terms and conditions hereof shall be binding upon FARO and the Purchaser, and shall be construed in accordance with the laws of the State of Florida, United States of America.

7.04 FARO shall be entitled to recover all of its reasonable fees and costs including, but not limited to, its reasonable attorney's fees incurred by FARO in connection with any dispute or litigation arising thereunder or in connection herewith, including appeals and bankruptcy or creditor reorganization proceeds.

7.05 These conditions shall not be construed more strictly against one party than another as a result of one party having drafted said instrument.

8.00 Definitions

8.01 "FARO" means FARO Technologies, Inc.

8.02 "Purchaser" means the party buying the Product and who is legally obligated hereunder.

8.03 "Software" means all computer programs, disk drive directory organization and content, including the computer media containing such computer programs and disk drive directory organization and content, sold pursuant to the Order.

8.04 "Product" means the FaroArm, the Software, operating manuals and any other product or merchandise sold pursuant to the Order. If the Purchaser is buying only a FaroArm, or the Software, Product will mean the product being purchased by the Purchaser pursuant to the Order.

8.05 "System" means a combination of the FaroArm, the Software, the Computer, and optional parts and accessories associated with the FaroArm.

8.06 "Certified user" means any person who has completed and passed the written exam issued by FARO. The exam is available upon request.

8.07 "Purchase Order" means the original document issued from the Purchaser to FARO, listing all parts and/or services to be purchased and the agreed purchase price.

8.08 "Maintenance/Warranty Transfer Form" means a document to be completed for the transfer of the FARO Maintenance/Warranty. This document is available from FARO upon request.

Appendix C: Industrial Products Service Policy

A one-year maintenance/warranty comes with the purchase of new FARO manufactured hardware products. Supplemental Service Plans are also available at additional cost. See *Appendix D: Industrial Service Policy* for further details.

FARO Hardware under Maintenance/ Warranty

The following is a summary of what services can be obtained under the original warranty or Supplemental Service Plan.

- 1 Factory repairs on FARO-manufactured hardware products.
- 2 Factory repairs are targeted for completion within 7 (FaroArms) or 14 (FaroArms and Laser Scanners) working days of FARO's receipt of the defective item. The customer is responsible for returning the hardware to FARO in the original packing container or custom case.
- 3 FARO will return the hardware via 2-day air service to the Continental U.S. Outside the Continental U.S., FARO will return the hardware to the customs broker via 2-day air service. Expedited service can be arranged at the customer's expense.
- 4 Upon expiration of original warranty a Supplemental Service Plan may be purchased and can be renewed annually on FARO-manufactured hardware products.
- 5 All Supplemental Service Plans will be due for renewal at the end of the month in which the Service Plan or warranty was purchased, plus 12 months.
- 6 The original warranty and Supplemental Service Plan are transferable to subsequent owners under certain conditions:
 - The FaroArm is currently under the original warranty and Supplemental Service Plan.
 - New owner is, or becomes, a certified user.
 - A FARO Transfer of Original Warranty or Service Plan Agreement form is completed and submitted to Customer Service.

FARO Hardware NOT under Maintenance/

Warranty

Factory assessments and repairs on FARO-manufactured products will follow the following procedure:

- 1 The customer obtains a service number from FARO's Customer Service Department.
- 2 The customer sends the part to FARO with the service number on the label along with payment or a corporate purchase order for system testing and evaluation, which includes calibration and recertification.
- 3 The payment will be applied toward the total service cost beyond the initial payment. The estimated repair cost will be given to the customer prior to the repair. The total cost must be paid prior to beginning the service.
- 4 System testing and evaluation can take up to 30 days. FARO-manufactured part repairs can take up to 60 days. However, the part will be scheduled for service as soon as it arrives at FARO's factory.
- 5 The customer is responsible for all shipping charges to and from FARO, including import and export fees for international customers.

FARO Software

All FARO Software users will receive maintenance releases until the end of life for the version at no charge electronically or at a minimal fee for the computer media package. All enhancement and functionality upgrades will be available for purchase upon release.

Hardware & Software Training

FARO's training program is designed to instruct trainees in the operation of FARO's hardware and software, which the customer has purchased. The training classes are set up for each trainee to obtain valuable hands on application exposure. This will help the trainees in their everyday use of the hardware and software. FARO also feels that once the trainee completes the training, finding solutions to problems or applying applications will be simpler. Details are as follows:

- 1 The training class will prepare attendees to successfully attain an operators certification (see *Certification Requirements* section for more details).
- 2 The fee schedules for advanced additional training courses can be obtained from Customer Service, or the Sales department.

Certification Requirements

The FaroArm operator's inherent ability to understand 3D concepts may be in their background training. However, the precision with which the operator performs 3D measurements with the FaroArm is critical in establishing the accuracy and repeatability of the results of subsequent measurements.

In order to establish the proficiency of FaroArm operators, FARO has instituted an Operator Certification program, where each operator's knowledge and understanding of the FaroArm is evaluated. The successful operator is awarded a certificate which identifies him/her as an accredited FaroArm operator. The requirements are as follows:

- 1 Attend a FARO-conducted basic training course, either at a FARO Facility or on site at your facility.
- 2 Certification will be awarded once the class has been completed, and then the certified user will be registered for hardware and software support.

To certify an operator, call FARO's Training Department, 800.736.0234 (North America), +1 407.333.9911 (Worldwide), for updated information.

FaroArm Repair Fee Schedule

(Out of Maintenance/Warranty Owners Only!)

System Testing and Evaluation Fee - Contact your local FARO Service Center for pricing.

A fee is charged for any system testing and evaluation. This includes system diagnosis, calibration and/or recertification, and applies to all FaroArms. However, this fee does not include disassembly/repair costs if required. An estimated cost for disassembly/repair will be given to the customer prior to the repair. The disassembly/repair charges must be paid in full prior to the actual disassembly/repair. However, if no repairs

are needed the fee will be applied to the cost of system testing and evaluation. All evaluations contain a recertification. Re-certification will be performed on an “as needed” basis.

Contact your local FARO Service Center for the current system testing and evaluation fee pricing.

Repair Times

Calibration and/or Recertification Only - Can take up to 14 days to complete.

Disassembly and Repair - Can take up to 60 days to complete. This time is dependent on the supply of purchased components.

*Includes Calibration and Recertification



Transfer of Original Warranty or Service Plan Agreement

(SELLER'S CORPORATE OR INDIVIDUAL NAME AS APPLICABLE),

hereby waives all rights under the warranty service policy for
FaroArm Serial Number _____
CAM2 Port Lock Number _____
purchased originally on _____ (DATE).

(BUYER'S CORPORATE OR INDIVIDUAL NAME AS APPLICABLE),

hereby assumes all rights and obligations of the Hardware and/or Software
Warranty Service Policy from _____ (DATE OF
TRANSFER).

This transfer is only valid under the following conditions.

- 1 The FaroArm is currently under maintenance/warranty
- 2 New owner is, or becomes, a certified user.
- 3 This maintenance/warranty transfer form is completed and submitted to FARO Customer Service.

AGREED

(PRINT SELLER'S CORPORATE OR INDIVIDUAL NAME AS APPLICABLE) (PRINT SELLER'S CORPORATE OR INDIVIDUAL NAME AS APPLICABLE)

BY _____ BY _____
X _____ X _____

(PRINT NAME OF SIGNATORY) (PRINT NAME OF SIGNATORY)
FARO Technologies Inc.

Approved by x _____

(PRINT NAME OF SIGNATORY)

Appendix D: Industrial Service Policy

This Service Plan (hereafter, the “Plan”) is part of the Operating Manual for the FARO manufactured product purchased from FARO TECHNOLOGIES INC. (hereafter, “FARO”). The Plan and all of the optional additions, are subject to the conditions in Appendices A, B, & C, and are subject to change. This appendix refers to FARO’s service plans as written in the sales advertising literature, and is meant to provide additional details that the literature does not permit.

1.00 The purchase of the Plan shall occur with the purchase of the FARO products.

1.01 The plan shall apply to systems exclusively created or authored by FARO.

1.02 The plan shall include FARO product hardware only, and can not be extended or transferred through the sale of any part of the system to a third party unless the entire system has been sold or transferred.

1.03 The plan shall not cover Hardware or Software which has been subjected to misuse or intentional damage. FARO reserves the right to determine the condition of all returned Hardware and/or Software.

1.04 FARO shall determine the service method and contractor to service/repair all hardware which is not directly manufactured by FARO. All outside contractor terms and conditions are available from FARO and are incorporated herein by reference.

1.05 FARO shall not be responsible for any non-FARO authored software which inhibits the operation of the system. Furthermore the plan will not cover the re-installation of any software.

1.06 The Hardware and Software are subject to changes in design, manufacture, and programming. All updates are as follows:

a) Hardware - The FaroArm and all of the associated optional parts, and the Computer are not subject to updates.

b) Software - All computer programs, authored by FARO, which are used in conjunction with the FARO provided Hardware, will be updated (maintenance upgrades) for the life of the Purchaser’s current version. All enhancement and functionality upgrades must be purchased.

c) 3rd Party Software - All computer programs not authored by FARO will not be updated under the Plan. The purchaser is responsible for the acquisition of all 3rd party software updates and warranty service or claims.

1.07 In the event that FARO replaces any product or replacement product, FARO retains all right, title, and interest in and to all products or portions of products that were replaced by FARO.

2.00 Definitions

2.01 “FARO” means FARO Technologies, Inc.

2.02 “Purchaser” means the party buying the Product and who is legally obligated hereunder.

2.03 “Software” means all computer programs, disk drive directory organization and content, including the diskettes containing such computer programs and disk drive directory organization and content, sold pursuant to the Order.

2.04 “Product” means the FaroArm, the Software, operating manuals and any other product or merchandise sold pursuant to the Order. If the Purchaser is buying only a FaroArm, or the Software, Product will mean the product being purchased by the Purchaser pursuant to the Order.

2.05 “System” means a combination of the FaroArm, the Software, the Computer, and optional parts associated with the FaroArm.

2.06 “Hardware” means the FaroArm and all of the associated optional parts, and the Computer if provided by FARO.

2.07 “Software” means all computer programs, authored by FARO, which are used in conjunction with the FARO provided Hardware.

The following is a layman’s definition of the coverage.

Standard Service Plans

All shipping times below are to destinations within the Continental United States. Outside the Continental U.S., FARO will ship equipment directly to the customs broker.

- Standard Service Plans are contracted at time of purchase or at any time while a unit is covered by a FARO hardware service plan (as described in more detail later).
- The Standard Service Plan covers the FaroArm and controller box.

- Shipping costs, including insurance from the Purchaser to FARO are the responsibility of the Purchaser. FARO will be responsible for all return shipping costs including insurance.
- All reasonable efforts will be made to keep the service repair time within 7 (FaroArm) or 14 (FaroArm and Laser Scanner) working days. The equipment will be returned via 2-Day air service, therefore, total service repair time will vary due to return shipping location.
- Since the FaroArm is designed to be used with many other software packages not authored by FARO, this service plan can be purchased in its entirety to cover only FARO produced or authored products. For items not produced or authored by FARO, the customer is responsible for securing their own separate warranty or service plan coverage.

Hardware Coverage

FaroArm

Covered

- All parts and labor for FaroArms failing under normal use as described in Appendix B.
- Annual calibration and re-certification of the FaroArm.

Not Covered

- Misuse
- Intentional damage
- Wear and tear of probes, ball bars, auxiliary hardware products such as cables, wrenches, hex keys, screwdrivers, etc.

Computer

Covered

- FARO contracts with 3rd party service providers for this service for up to 3 years. The terms and conditions of FARO's contract with the provider apply herein and are incorporated herein by reference.
- Typically, these services include repair of the computer, memory cards, and video monitors.

Not Covered

- All exclusions contained in the 3rd party service providers policy which is incorporated herein by reference.
- Software operating system installation.

- User intentional or unintentional removal of key software property or files.

Software Coverage

Covered

- Periodically, FARO Technologies may release maintenance updates of its proprietary software. This will be supported through the life of the product version. All enhancement and functionality upgrades will be available in the next full version for a fee.

Not Covered

- End users are responsible for the procurement and installation of 3rd party authored or S/W updates as required to use with FARO authored software products, unless FARO Technologies resold these packages to the end user as an authorized reseller. Examples of 3rd party authored S/W are: DOS, Windows, AutoCAD, AutoSurf, SurfCAM and others.

Premium Service Plans

The Premium Service Plans additionally provide loaner FaroArms and Computers when service is required. All equipment shipping costs are paid for by FARO (both ways). FARO will make its best effort to ship all loaner FaroArms within 24 hours of the receipt of the purchasers request. Once the need for a service has been verified by FARO, FARO will make its best effort to ship all loaner computers within 72 hours of the receipt of the purchaser's request.

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