

QUANTUM

FaroArm® and Laser ScanArm® Quantum
User Manual
August 2017

FARO



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Chapter 1: Introduction

Thank you for choosing FARO’s Portable Measurement Arm - the FaroArm®, and FARO’s Portable Laser Line Measurement Arm - the Laser ScanArm®. This document contains detailed instructions on how to use your Quantum series FaroArm and the FARO Laser Line Probe with the CAM2® Measure. Additional information about probes and important guidelines on maintaining your new Quantum/ScanArm is also included.

This introduction contains information on how to reach FARO, how to read the manual, and a brief overview of the Quantum. If you have any questions or need further instructions about any procedure, contact your Customer Service Representative by Phone, Fax or E-Mail. See “*Technical Support*” on page 161.

Visit the FARO Customer Care area on the Web at www.faro.com to search our Knowledge Base. The Knowledge Base is available 24 hours a day, 7 days a week, and contains hundreds of solutions to product and application questions.

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How To Use This Manual

Listed below are some visual and typographical conventions used in each of the sections.

Bold text	Indicates directory names, menu names, buttons, tabs, key names, acronyms, and modes.
<code>monospaced text</code>	Indicates alphanumeric characters or values you enter in a field on the screen. For example, “Type 0.005 for the tolerance setting.”
SMALL CAPS text	Indicates dialog box names, and dialog box items.

It is important that you understand the meaning of the following words before proceeding.

digitize	Indicates the recording of XYZ coordinates of a point or location in 3D space. The word digitize is the same as the term <i>measure</i> when referring to points.
choose or select	Indicates that you are initiating an action. For example, “Select File > Insert > CAD Parts .”
left-click, right-click, click, or press	Indicates that you press and release the corresponding mouse button or keyboard key. Also used when referring to the hardware device buttons. For example, “After selecting a file from the OPEN FILE dialog box, <i>click</i> OK to open the file” or “ <i>Press</i> ESC at anytime to cancel a command.”
drag	Indicates that you press and hold the left mouse button down and move the mouse. Release the mouse button to finish. This word is often used when changing the size of a window or toolbar.

Warning

A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or event that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a **WARNING** notice until the indicated conditions are fully understood and met.

Caution

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or event that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

Note

A **NOTE** notice denotes additional information that aids you in the use or understanding of the equipment or subject. Specifically, they are not used when a **WARNING** or **CAUTION** is applicable. They are not safety related and may be placed either before or after the associated text as required.

General Information

The Quantum is a multiple-axis, articulated arm with a spherical working volume. Each joint has a rotary optical encoder. The signals from these encoders are processed, using advanced error coding and temperature compensation technology, and positional data is sent to the host computer using various wired and wireless communication protocols.

The Base Assembly contains the majority of the electronics, including a power on/off button, wireless on/off buttons, status indicators, battery pack bay, and communication ports. There are five major communications ports on the Quantum located on the Base Assembly:

- USB 2.0 Host Port
- USB 2.0 Device
- Ethernet (802.3)
- Bluetooth (Internal Base Module)
- Wireless Local Area Network (WLAN 802.11 - Internal Base Module)

The Quantum uses a non-volatile read/write FLASH memory. This memory stores programming and some compensation data for the Quantum. There are proprietary methods that are capable of erasing, reading, and writing the FLASH memory. These methods are used during manufacturing and field updating. Security for the FLASH is limited to the anonymity of the access methods and the unavailability of documentation for the address structure of the FLASH memory.

The only dynamic data stored in the Quantum are settings which relate directly to the operation of the Quantum. Examples include the probe XYZ position, connection settings, etc. The Quantum does not maintain in memory, or cache, measurement data of any type. Measurements recorded with the Quantum are sent directly to the properly connected computer.

The Probe End Assembly is found at the farthest point from the base. It is free to rotate, has two control (red and green) buttons and two circular LED indicators that provide visual feedback to the user. This assembly provides for the attachment of probes and handle accessories.

6-Axis Quantum

These are the key components and controls for the 6-Axis Quantum.

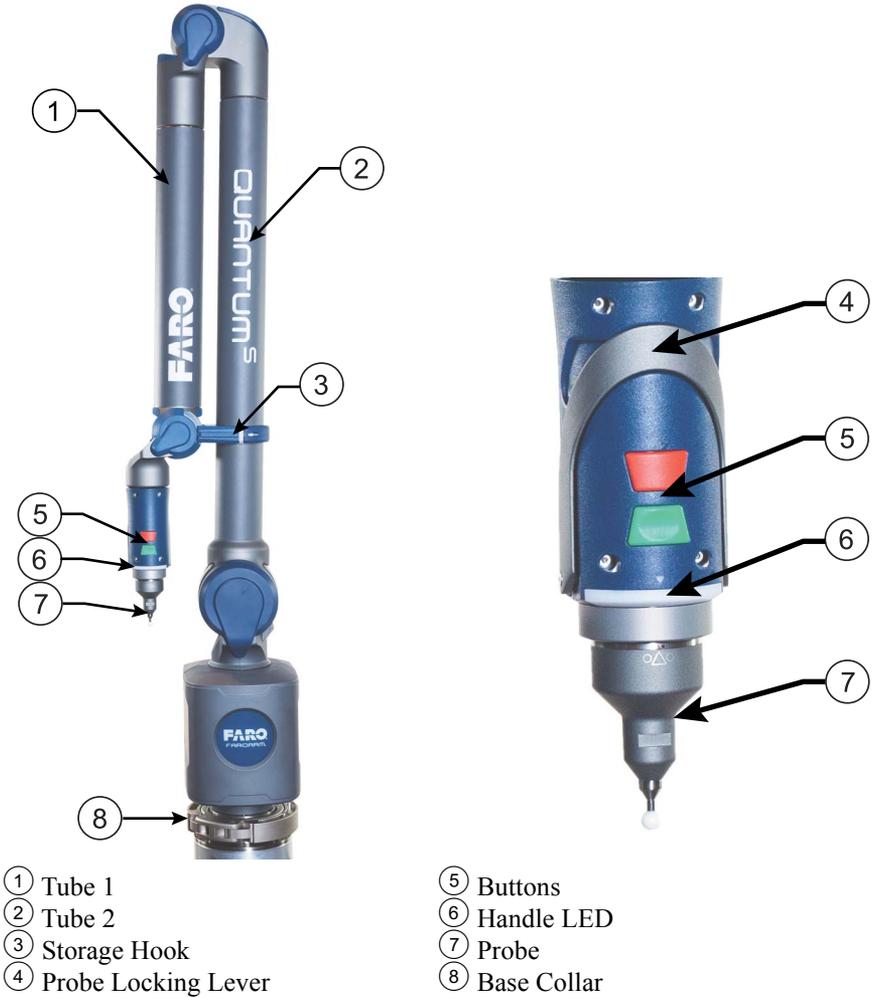
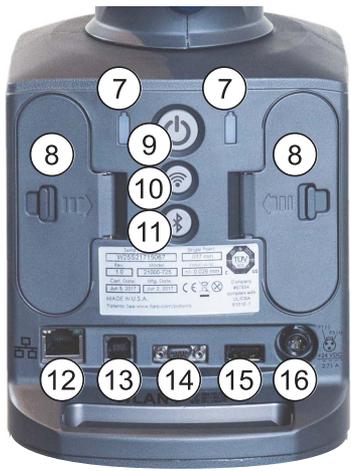


Figure 1-1 6-Axis FaroArm front view



- ① Tube 2
- ② Tube 1
- ③ Storage Hook
- ④ Buttons
- ⑤ Handle LED
- ⑥ Probe
- ⑦ Battery Power Indicators
- ⑧ Battery Doors
- ⑨ Power On/Off Button
- ⑩ WLAN On/Off Button
- ⑪ Bluetooth On/Off Button
- ⑫ Ethernet Port
- ⑬ USB Port
- ⑭ Auxiliary Port
- ⑮ Powered USB Port
- ⑯ Power Supply Port
- ⑰ Lifting Handle
- ⑱ Base Collar

Figure 1-2 6-Axis FaroArm back view

7-Axis Quantum

These are the key components and controls for the 7-Axis Quantum.

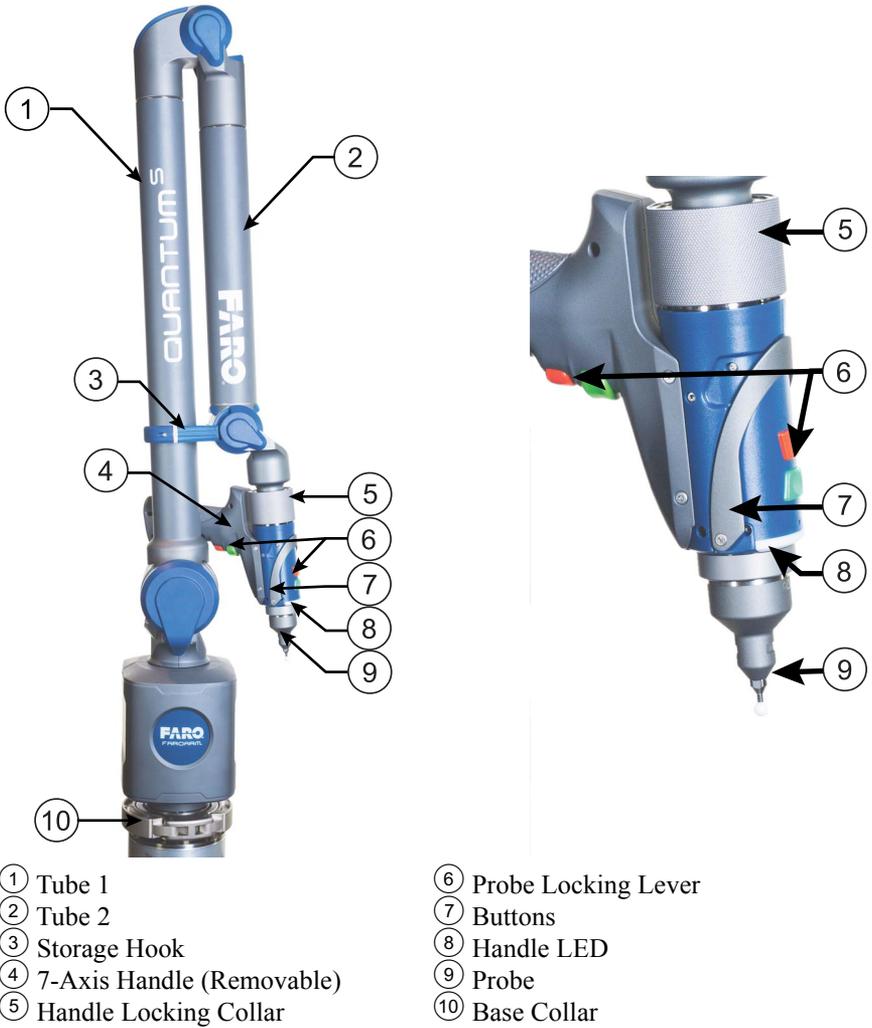
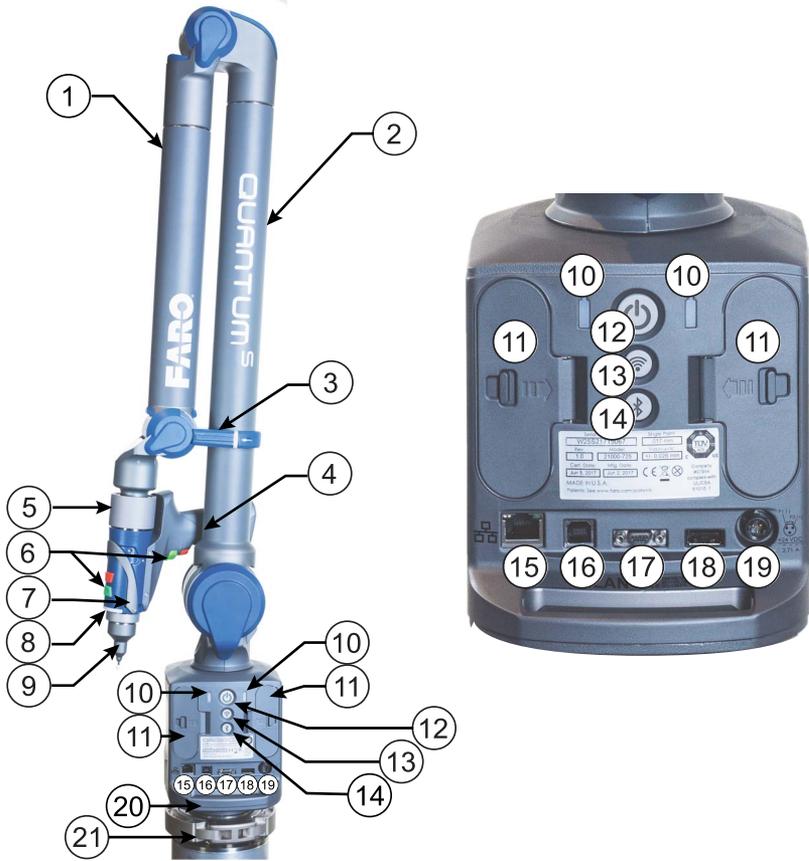


Figure 1-3 7-Axis FaroArm front view



- ① Tube 1
- ② Tube 2
- ③ Probe
- ④ 7-Axis Handle (Removable)
- ⑤ Handle Locking Collar
- ⑥ Buttons
- ⑦ Probe Locking Lever
- ⑧ Handle LED
- ⑨ Probe
- ⑩ Battery Power Indicators
- ⑪ Battery Doors
- ⑫ Power On/Off Button
- ⑬ WLAN On/Off Button
- ⑭ Bluetooth On/Off Button
- ⑮ Ethernet Port
- ⑯ USB Port
- ⑰ Auxiliary Port
- ⑱ Powered USB Port
- ⑲ Power Supply Port
- ⑳ Lifting Handle
- ㉑ Base Collar

Figure 1-4 7-Axis FaroArm back view

Safety Labels

Notice the following safety labels on your Quantum.

Pinch Points

Labels that indicate pinch points are located on near the joints. Avoid placing hands and fingers in these pinch points. See Figure 1-5 for the location of the pinch point labels.

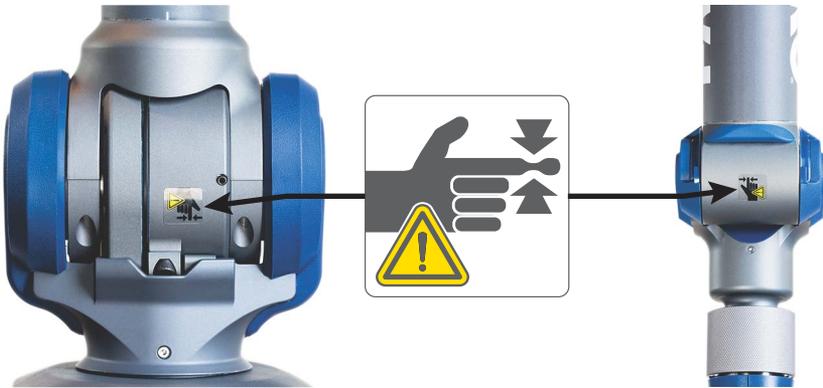


Figure 1-5 Pinch Point Labels

Precautions

The Quantum is a precision measuring device that is ruggedized for shop use; however, care must still be exercised in the operating environment when using the Quantum. Proper operation and care includes avoiding:

- Solvents.
- Abuse, such as dropping or twisting at end stops.
- Moisture and high humidity.
- Power fluctuations. See “*Quantum Power Supply*” on page 32.
- Excessive temperature changes without appropriate elapsed time. See “*Temperature Considerations*” on page 122.

CAUTION: Using the Quantum in a manner not specified by the instructions in this manual will impair the protection provided by the design of the product.

Your FaroArm and Laser ScanArm can give you many years of service when you treat it with care.

Regulatory Information

Regulatory information for the wireless components of the Quantum is listed on the back of the base.



Figure 1-6 Wireless regulatory information label

Bluetooth

FCC ID: Z64-WL1835MOD

IC: 4511-WL1835MOD

MIC: 201-135370

DECLARATION OF CONFORMITY

FCC Compliance Statement:

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Information To The User:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/television technician for help.

CAUTION: Any change or modification not expressly approved by FARO Technologies, Inc. may void the user's authority to operate the equipment.

DECLARATION OF CONFORMITY

Industry Canada Statement:

This device complies with RSS-210 of Industry Canada.

Operation is subject to the following two conditions:

1. This device may not cause interference, and
2. this device must accept any interference, including interference that may cause undesired operation of the device.

CAUTION: EXPOSURE TO RADIO FREQUENCY RADIATION

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population: consult Safety Code 6, obtainable from Health Canada's website www.hc-sc.gc.ca/rpb

Wireless Local Area Network (WLAN 802.11)

FCC ID: Z64-WL1835MOD

IC: 4511-WL1835MOD

MIC: 201-135370

DECLARATION OF CONFORMITY

FCC Compliance Statement:

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Information To The User:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency

energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/television technician for help.

CAUTION: Any change or modification not expressly approved by FARO Technologies, Inc. may void the user's authority to operate the equipment.

NOTE: The WLAN (802.11b/g) can be used concurrently with the USB Device, LAN (Ethernet) and Bluetooth ports. **The Bluetooth and WLAN can be disabled by hardware and firmware.**

Industry Canada Statement:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

CAUTION: EXPOSURE TO RADIO FREQUENCY RADIATION

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population: consult Safety Code 6, obtainable from Health Canada's website www.hc-sc.gc.ca/rpb

To comply with RF exposure requirements all antennas should be located at a minimum distance of 20cm, or the minimum separation distance allowed by the module approval, from the body of all persons.

European Union:

The FaroArm Quantum complies with the protection requirements of the Council Directives 2014/30/EU (Electromagnetic Compatibility), and 2014/35/EU (Low Voltage Directive on Electrical Safety) and 1999/5/EC (R&TTE applies to radio equipment) as per requirements of the laws of the Member States.



Product Environmental Information

Legislation is now in place within the European Union (EU) that regulates waste from electrical and electronic equipment (WEEE). European Directive 2012/19/EU on Waste Electrical and Electronic Equipment (the WEEE Directive) stipulates that WEEE is now subject to regulations designed to prevent the disposal of such waste and to encourage design and treatment measures to minimize the amount of waste that is placed into the waste stream. The objective of the WEEE Directive is to preserve, protect and improve the quality of the environment, protect human health, and stimulate the practical use of natural resources. Specifically, the WEEE Directive requires that producers of electrical and electronic equipment be responsible for the collection, reuse, recycling and treatment of WEEE which the Producer places on the EU market after August 13, 2005.

FARO Technologies, Inc., as a producer of electrical and electronic equipment (EEE), has endeavored to meet these environmental responsibilities for managing WEEE. In so doing, FARO is providing the following to inform its customers about the WEEE collection process:

In order to avoid any potential dissemination of hazardous substances into the environment, FARO has labeled this product with the WEEE symbol (see below) in order to alert the end-user that it should be disposed of within the proper waste management system. That system will recycle, reuse, and dispose of materials from this product in an environmentally sound way.

The symbol represented below, and found on this FARO Technologies, Inc. product, indicates that this product meets the European Directive 2012/19/EU on Waste Electrical and Electronic Equipment. This symbol, only applicable in European Union countries, indicates that when this product reaches the end of its useful life it should not be disposed of with normal household or municipal waste, but in an established waste stream for WEEE.

Each EU Member State country has established a system for the collection, disposal, and recycling of WEEE. End-users in the EU should contact their local waste administration system for collection instructions concerning this product.

Refer to www.faro.com for further environmental information concerning this product.

This product is in compliance with the DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHs).




WEEE Symbol

Chapter 2: Setting up the Quantum

This chapter describes the unpacking, mounting, connecting, powering up, and powering down of the Quantum system. You should also refer to the *FaroArm Quantum Assembly Instructions* booklet found inside the lid of your shipping case.

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The Quantum Packing Contents

The following components and accessories are standard items shipped with every system:

Quantum - Packing List	
<input type="checkbox"/>	Shipping case
<input type="checkbox"/>	Quantum
<input type="checkbox"/>	Probe case:
<input type="checkbox"/>	3 mm i-Probe
<input type="checkbox"/>	6 mm i-Probe
<input type="checkbox"/>	FARO Compensation Cone and T-shaped fixture
<input type="checkbox"/>	FARO Compensation Sphere

Quantum - Packing List	
<input type="checkbox"/>	Accessories pocket: <ul style="list-style-type: none"><input type="checkbox"/> Power Supply<input type="checkbox"/> USB cable<input type="checkbox"/> Lithium Ion Smart Battery Pack<input type="checkbox"/> Dust cover<input type="checkbox"/> FaroArm Driver USB flash drive<input type="checkbox"/> FaroArm Manual USB flash drive<ul style="list-style-type: none"><input type="checkbox"/> <i>FaroArm Manual</i> (this book)<input type="checkbox"/> <i>FaroArm Accessories Manual</i>
<input type="checkbox"/>	Documentation pocket: <ul style="list-style-type: none"><input type="checkbox"/> Quantum Assembly Instructions<input type="checkbox"/> Product Environmental Information European Union sheet<input type="checkbox"/> Quantum Calibration Documents
<input type="checkbox"/>	Surface Mount Plate
<input type="checkbox"/>	7-Axis Handle (7-Axis models only)
<input type="checkbox"/>	FARO Laser Line Probe HD in separate Shipping case (optional)

Optional Accessories

The *Accessories Manual* that is on your FaroArm Manual USB flash drive lists all of the optional accessories that you can order from FARO. Installation and detailed operational instructions are included.

The *Accessories Manual* is also available on FARO's Web site at www.faro.com. To purchase optional accessories, contact FARO's Customer Service by Phone, Fax or E-Mail. See "*Technical Support*" on page 161.

Shipping Case



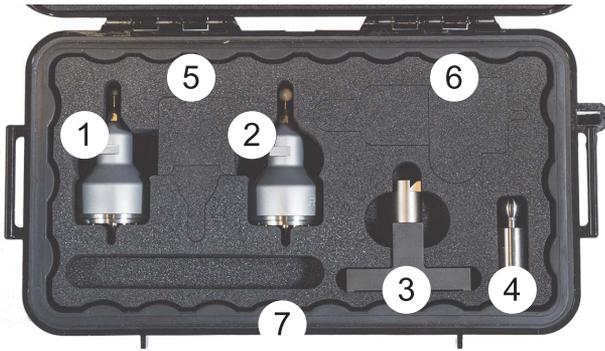
- ① Quantum
- ② Probe Case
- ③ Accessories Pocket
- ④ 7-Axis Handle
- ⑤ Surface Mount Plate
- ⑥ FaroArm Driver and User Manuals
- ⑦ Documentation Pocket

NOTE: The 7-Axis Handle is not available for 6-Axis Quantums.

NOTE: The FARO Laser Line Probe HD case does not fit in the Shipping case.

Figure 2-1 Quantum Shipping case

Probe Case



- ① Probe, 6 mm Ball
- ② Probe, 3 mm Ball
- ③ Compensation Cone
- ④ Compensation Sphere
- ⑤ Additional Probe Storage
- ⑥ Renishaw Adapter Storage
- ⑦ Probe Kit Case

Figure 2-2 Quantum Probe case

Unpacking the System

The Quantum is packed in a shipping case which includes space for the Cables, Probes, and mounting hardware.

Lifting the Quantum

Follow safe lifting procedures when removing the Quantum from its storage case. Always use safe lifting procedures when placing the Quantum on, or removing the Quantum from, the tripod.

- While in the case, lift Tube 2 and rotate it to place it onto Tube 1.
- Reach under and grab the Quantum by Tube 1 and the base handle to remove it from the case.



Figure 2-3 Lifting the Quantum

Hardware Setup

The following sections describe the proper setup of the Quantum system. This includes attaching the Quantum to your work surface or tripod, and connecting the Quantum to your computer.

Mounting the Base

The counterbalance by the tension spring generates torque at the base of the Quantum; therefore, the mount must meet certain requirements to achieve optimum machine accuracy.

CAUTION: The Quantum *must* be mounted in a upright position. *Do Not* mount the Quantum in an inverted (upside down) or sideways position.

If you are not using a tripod, attach the 3½” threaded ring and surface mount plate to any stable location. To mount the Quantum:

1. Remove the Quantum from the Shipping case.
2. Place the Quantum onto the 3½” ring of your tripod or surface mount plate. Thread the base collar onto the ring and hand tighten.
3. Tighten the base collar using the attached handles.



Figure 2-4 Mounting the Quantum

For more information see “*Mounting Stiffness Test*” on page 120 and “*Quantum Performance Verification Checklist*” on page 132.

CAUTION: Always remove the Quantum from the tripod before moving the tripod to another location.

Storage Hook

The Quantum has a Storage Hook attached to Tube 1 to secure Tube 2. This system helps secure the Quantum and helps prevent damage to the probe when in the rest position.

1. Lift the last section upwards and insert the bottom of Tube 2 into the Storage Hook.



Figure 2-5

2. Ensure both sides are in the hook and gently lower the last section.



Figure 2-6

3. Lift the last section upwards to remove Tube 2 from the Storage Hook to begin measuring.

Installing Probes

Remove the Probe Kit case from the Shipping case. In addition to probes, this case contains the compensation cone. The probe attaches to the handle at the end of the Quantum. To install a probe:

1. Hold the end of the Quantum on the underside with one hand and open the probe locking lever with your other hand.



Figure 2-7 Opening the Probe Locking Lever

2. Slide the probe onto the end of the Quantum. Rotate the probe until the marks on the probe and the handle match.



Figure 2-8 Installing a Probe

3. Close the probe locking lever.

Before measuring with the Quantum the probe must be compensated. Use the **Probes** command in your measuring software, to set up and compensate the probe.

For more information, see “Probes” on page 55.

NOTE: All FARO i-Probes have a unique serial number. After compensating an i-Probe, the compensation information stores on your computer. If you remove the i-Probe and reinstall it later, the Quantum automatically loads the compensation data.

7-Axis Handle

NOTE: 7-Axis models only.

You can attach the 7-Axis Handle, a pistol-grip handle, to the Quantum Handle to give you another control option. This handle stores in a cutout of the Shipping case foam. The 7-Axis Handle *can* be attached/detached while the Quantum is powered On. The FARO Laser Line Probe attaches in the same method. See “*Hardware Installation*” on page 91. To attach the handle:

1. Loosen the locking collar.



Figure 2-9 Loosening the Locking Collar

2. Remove the protective cover.



Figure 2-10 Removing the Protective Cover

3. Insert the front edge of the 7-Axis Handle into the slot.



Figure 2-11 Inserting the 7-Axis Handle

4. Push the 7-Axis Handle in so that the connectors connect.



Figure 2-12 Attaching the 7-Axis Handle

5. Tighten the locking ring by turning it in the opposite direction. Tighten the ring until it clicks.



Figure 2-13 Tightening the Locking Collar

NOTE: Remove the 7-Axis Handle from the Quantum before packing.
See “Packing the Quantum” on page 29.

Wired connections

The Quantum connects to the computer using a standard USB cable, or a standard Ethernet cable. High speed operation is supported.

CAUTION: Complete all cable connections before applying power to the computer and the Quantum.



- ① On/Off Button
- ② Ethernet Port
- ③ USB Port

Figure 2-14 Quantum wired communication ports

For more information, see “Wired connections” on page 39.

You can also connect your Quantum to your computer using standard wireless connections. *For more information, see “Wireless Connections” on page 40.*

Supplying Power to the Quantum

Place the Quantum in an area with a properly grounded outlet receptacle. The On/Off button is located on the back side of the base. Connect the power supply cord to the port on the back side of the base.



- ① On/Off Button
- ② Power Supply Port

Figure 2-15 Quantum Power

WARNING: Do Not disconnect or isolate the ground pin on the power supply cord.

Select the proper power supply cord intended for installation in a protected environment. The power supply automatically adjusts to the voltage.

- For 120V Connection: Use a UL Listed, type SJT or SVT, 3-Conductor, 18 A.W.G. power supply cord, terminating in a molded-on plug cap rated 125 VAC, 15A minimum, with a minimum length of six feet.
- For 220 - 240V Connection: Use an international harmonized, 300V rated, PVC insulated jacket, three conductors of 0.75 mm² minimum cross-sectional area, each with a molded-on plug cap marked with proper agency marking for the country where it will be used.

Connect the power supply cable to a source of power with a protective earthing connection (properly grounded).

WARNING: Do Not use any power supply cord other than the cord provided with this unit.

CAUTION: Ensure that the power supply cord plug is easily accessible.

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

Quantum Battery Pack

Your Quantum may be powered using the two supplied battery packs. Install each battery pack to power your Quantum when you are not near a grounded power outlet.

NOTE: It is not necessary to install the battery pack if the Quantum is connected to a grounded power outlet.

Installing the Battery Pack

1. On the rear of the base, open the door to access the battery pack slot.

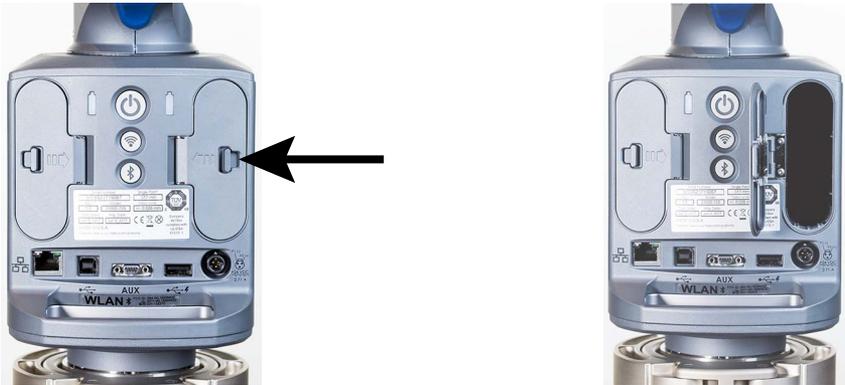


Figure 2-16 Opening the Battery Door

2. Rotate the battery pack so that the slot is facing towards the right and the cloth tab is facing you.
3. Slide the battery pack in with the slot to the inside.



Figure 2-17 Installing the Battery Pack

NOTE: Push the battery all the way in until it snaps into place.

4. Close the door and ensure the latch snaps.



Figure 2-18 Closing the Battery Door

Removing the Battery Pack

1. On the rear of the base, open the door to access the battery pack slot.
2. Grab the cloth strip and pull out the battery pack.



Figure 2-19 Removing the battery pack

3. Close the door and ensure the latch snaps.

CAUTION: Store the battery properly when not in use.

Charging the Battery Pack

Install the battery pack and connect the Quantum to a power outlet and the battery pack will begin to charge. The battery pack will charge if the On/Off button is set to the *OFF* position. Charging automatically stops when the battery pack is completely charged.

- The Battery Power Indicator show the battery pack power level.
- The DIAGNOSTICS dialog box displays the current battery pack power level. See “Diagnostics” on page 80.

WARNING: Only use the rechargeable battery pack supplied with your Quantum. For information on ordering additional or replacement battery packs, contact FARO’s Customer Service by Phone, Fax or E-Mail. See “Technical Support” on page 161.

You can also charge a battery pack using the Quantum Battery Charging Base. For more information about the charging base, see the *FaroArm Accessories Manual*.

Packing the Quantum

The Quantum should be packed very carefully to prevent shipping damage.

NOTE: The FARO Laser Line Probe HD case does not fit in the Shipping case.

1. Turn off the Quantum, remove the battery pack, disconnect all cables, and unlock the handle so it is hanging down.

NOTE: Remove the 7-Axis Handle from the Quantum before packing.
See “7-Axis Handle” on page 21.

Pack the ① Quantum, ② Probe Case, ③ Accessories, ⑤ Surface Mount Plate, and ⑥ 7-Axis Handle as shown.



- | | |
|----------------------|-----------------------------------|
| ① Quantum | ⑤ Surface Mount Plate |
| ② Probe Case | ⑥ FaroArm Driver and User Manuals |
| ③ Accessories Pocket | ⑦ Documentation Pocket |
| ④ 7-Axis Handle | |

Figure 2-20 Quantum Shipping case

NOTE: The FARO Laser Line Probe HD case does not fit in the Shipping case.

2. Close the Shipping case and secure all the case latches.

USB Devices

You can attach certain USB devices to the port on the rear of the base, This port is provided to charge USB devices. No data is sent to the device.



Figure 2-21 Powered USB Port

Auxiliary Port

On the rear of the Quantum base, an optional 9-pin communications port is available to connect external equipment. To get a list of approved FARO devices, contact your Customer Service Representative by Phone, Fax or E-Mail. See “*Technical Support*” on page 161.



Figure 2-22 Quantum Auxiliary port

WARNING: Only use FARO approved devices in this port. For more information about approved FARO devices, contact FARO’s Customer Service. Using other devices could damage your system and will void your maintenance/warranty service plan.

Quantum Power Supply

Power the Quantum with the supplied power supply. The power supply is NRTL Listed for US and Canada. For IEC member countries and Europe, the power supply must be certified for the country in which the equipment is sold. Contact FARO's Customer Service to order a replacement. All servicing should be referred to qualified service personnel.

Rated Voltage:	100 - 240V ~ 47 - 63 Hz
Voltage Tolerance:	+5% or -5%
Rated Input:	1.4A
Sec. Voltage:	+24 VDC
Sec. Current:	2.71A
Pollution Category:	2
Installation Category:	2

CAUTION:  **INDOOR USE ONLY**

Surface Mount Plate Dimensions

The Surface Mount Plate is used to clamp or bolt the Quantum to a stable mounting surface. It is an assembly of a standard 3½” mounting ring and a FARO-designed base plate.

You can bolt the Surface Mount Plate directly to a surface using the mounting screws in the Accessories Case. Make sure to tighten each mounting screw to 100-inch pounds.

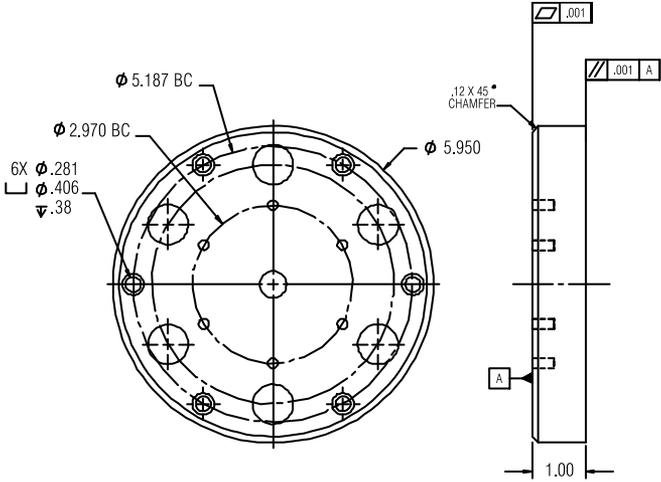


Figure 2-23 Surface Mount Plate dimensions

You can bolt the 3½” mounting ring directly to a surface using the mounting screws in the Probe case. Make sure to tighten each mounting screw to 100-inch pounds.

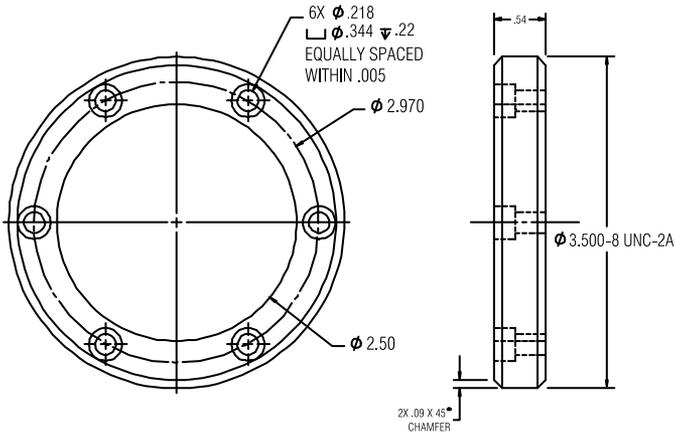


Figure 2-24 Standard 3½” Mounting Ring dimensions

Chapter 3: Operation

This chapter describes the controls, visual indicators, and advanced connection options for the Quantum. Make sure that you have read the setup instructions and set up your Quantum properly. *For more information, see “Setting up the Quantum” on page 13.*

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Numerical and Signal Processing

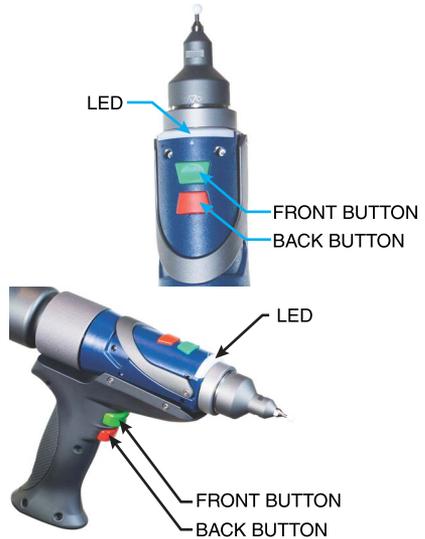
The Quantum contains a complete electronics system. Signals from each joint are processed and positional data is sent out to the host computer.

Handle LED

After applying power to the Quantum, the Handle LED is **Solid Yellow** while an internal startup check runs. After this is complete, the LED indicates the following:

- **Flashing Blue** - if the Quantum successfully communicates with the computer, and the encoders are not referenced. See *“Referencing the Encoders”* on page 38.
- **Solid Blue** - if the Quantum successfully communicates with the computer, and the encoders are referenced. See *“Referencing the Encoders”* on page 38.
- **Solid Green** - if the Quantum successfully communicates with the computer, and the encoders are referenced - Renishaw Probe only. See *“Renishaw TP-20 Probe Installation and Operation”* on page 109.
- **Solid Red** - if there is an error in the Quantum.

The LED will also indicate that a button is pressed. See *“Quantum Handle Buttons”* on page 37.



Quantum Handle Buttons

The Quantum Handle has two buttons and an LED. When a button is pressed, the LED light illuminates (green or red) and the host computer sounds. See “Handle LED” on page 36.



Figure 3-1 Quantum Handle Buttons

Use the **Front** button to collect readings and accept a measurement.

- The **Front** button is green and nearest the probe.

Use the **Back** button to record probe compensation or reject a measurement.

- The **Back** button is red and is nearest the handle.

Error and Status Indicators

Visible through the FaroArm driver interface to the measuring software, the Quantum generates and displays errors in the FAROARM dialog box, and the Handle LED turns **Solid Red**.

NOTE: The Quantum does not output data until the error has been cleared.

- The encoder end stop warnings - This warning appears when an encoder reaches one end of its rotation.

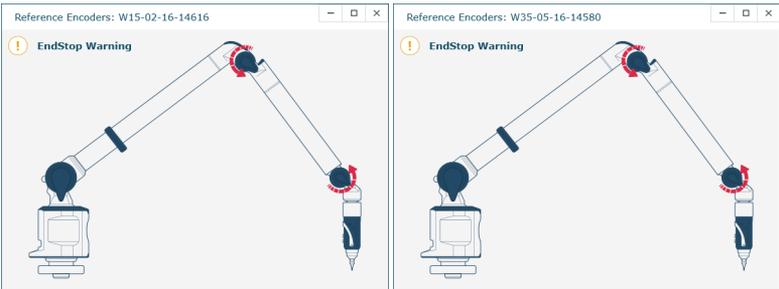


Figure 3-2 Quantum End Stop Warning

- The tube stress stop warnings - This warning appears when there is stress on one of the tubes or encoder joints. The stress stop warnings may be disabled. See “Hardware Configuration” on page 76.

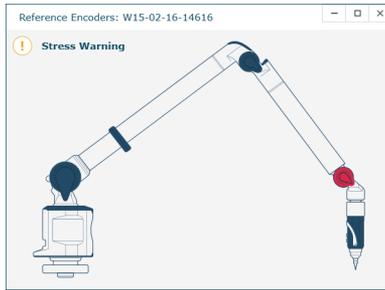


Figure 3-3 Quantum Stress Stop Warning

NOTE: Other errors appear in a message box.

Referencing the Encoders

You must first reference each of the six (seven) encoders in the Quantum before the system can output data. Pull the handle and each tube out of the rest position and move to make each encoder move. Each encoder must move to reference. The REFERENCE ENCODERS dialog box shows all seven encoders in error until each is referenced. In a systematic manner, rotate joints 1 through 6 (7) until each warning clears.

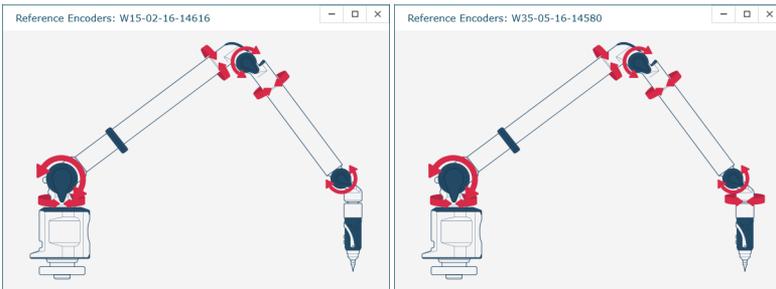


Figure 3-4 Referencing the Encoders

NOTE: The Quantum must be properly connected to the host computer running the measuring software to see the REFERENCE ENCODERS dialog box on the host computer.

Host Computer

The Quantum output is accepted through any PC-compatible computer using the following communication protocols:

- USB 2.0 (Device)
- Ethernet (802.3)
- Bluetooth
- Wireless Local Area Network (WLAN 802.11)

You can use multiple communication protocols with the following limitations:

- USB, Ethernet, and Bluetooth are active at the same time, WLAN is disabled
- USB and WLAN are active at the same time, Bluetooth is disabled.
- WLAN is disabled if Ethernet is active
- WLAN is disabled if Bluetooth is active

Wired connections

The Quantum is equipped to connect to your computer using different wired connections.

CAUTION: Complete all cable connections before applying power to the computer and the Quantum.



- ① On/Off Button
- ② USB Port
- ③ Ethernet Port

Figure 3-5 Quantum Wired Communication Ports

USB

USB communication connects from the Quantum to the computer using a standard USB cable. High speed operation is supported.

The USB connector is located on the back side of the base.

Ethernet

Ethernet communication connects from the Quantum to the computer using a regular or crossover twisted-pair Ethernet cable (Cat 5, Cat5e or Cat 6) with RJ-45 connectors. When Ethernet is used the Quantum is configured as a DHCP (Dynamic Host Configuration Protocol) client.

The Ethernet connector is located on the back side of the base.

NOTE: In a multiple computer networking environment, you should consult your Information Technology (IT) department for assistance with installing the Quantum.

After connecting the Quantum to the computer, start the FaroArm Manager program and choose Ethernet in the **Devices** group. *For more information, see “Ethernet” on page 54.*

Wireless Connections

The Quantum is equipped to connect to your computer using different wireless connections.



- ① WLAN On/Off Button
- ② Bluetooth On/Off Button

Figure 3-6 Quantum Wireless On/Off Buttons

FARO Wireless - Bluetooth

The Quantum is a Bluetooth equipped device and can connect to your computer without using a cable.

NOTE: The Bluetooth connection will not support Laser Line Probe use.

Bluetooth wireless is a short-range communications technology intended to replace the cables connecting devices. The range of a Class 2 system, such as the Quantum, is approximately 30 feet or 10 meters. Bluetooth devices are generally paired, or associated with each other, either openly or employing security, with one serving as the master device and the second as the slave. In the case of the Quantum:

- The Quantum is the slave.
- The host computer is the master.
- Basic PIN based security is employed.
- The host computer establishes an RS-232 emulation or Serial Port Profile (SPP) connection to the Quantum.
- Once the connection is established, the PC and Quantum can transfer data at a rate of 921600 bits/second.

NOTE: If your Quantum is connected with USB cable and Bluetooth, only the Bluetooth connection will be active.

To activate the Bluetooth signal, press the Bluetooth On/Off Button. Connect the Quantum to your computer:

- Using Bluetooth - Windows 10
- Using Bluetooth - Windows 7

Using Bluetooth - Windows 10

Create the wireless connection between the host computer and the Quantum using:

- The Devices category of the Windows Settings command.
- FaroArm Manager

NOTE: Ensure your computers Bluetooth radio is on. Some computers have a hard switch for the wireless receiver and some are only controlled through a software switch.

Quantum to the Computer Connection

1. Click **Start > Settings**.



Figure 3-7 Windows Task Bar menu

NOTE: You can also click the Bluetooth icon in the task bar menu and choose **Add a Device**.

2. Choose **BLUETOOTH** and then your Quantum. All Quantums are identified by their serial number.

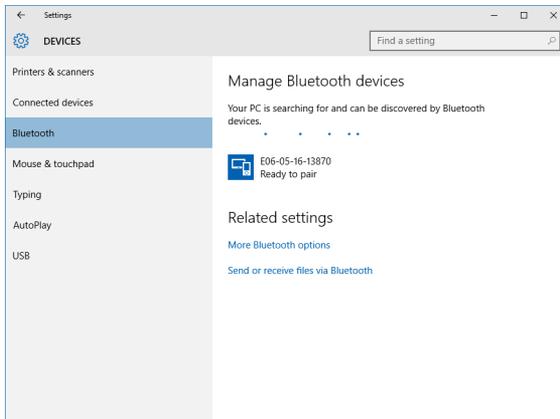


Figure 3-8 Choosing your Quantum

3. Click PAIR.

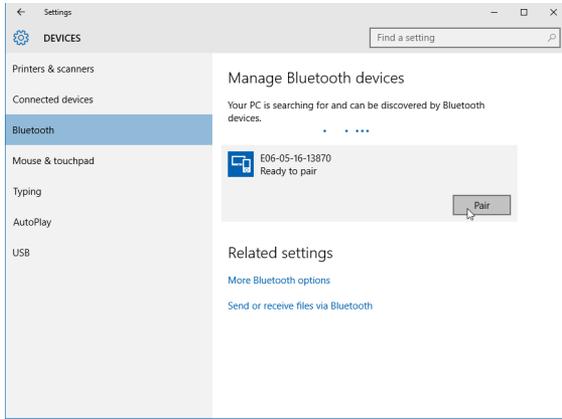


Figure 3-9 Pairing the Quantum

4. Enter the Quantum pairing code, **faro**, and click **Next** to create the SPP connection.



Figure 3-10 Entering the Pairing Code

The FaroArm driver connects to the SPP connection using the **FaroArm Manager**. See “FaroArm Manager” on page 46.

Using Bluetooth - Windows 7

Create the wireless connection between the host computer and the Quantum using:

- The **Devices and Printers** category of the Windows **Control Panel**.
- **FaroArm Manager**

NOTE: Ensure your computers Bluetooth radio is on. Some computers have a hard switch for the wireless receiver and some are only controlled through a software switch.

Quantum to the Computer Connection

1. Click **Start > Devices and Printers**.



Figure 3-11 Windows Task Bar menu

NOTE: You can also click the Bluetooth icon in the task bar menu and choose **Add a Device**.

2. Choose **Add a Device** from the menu in the upper left corner of the window. All Quantums are identified by their serial number. Double-click your Quantum.

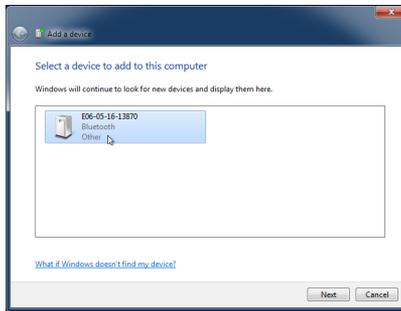


Figure 3-12 Choose your Quantum

3. Choose the **ENTER THE DEVICE'S PAIRING CODE** option and click **Next**.

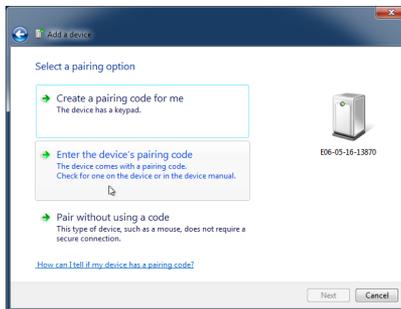


Figure 3-13 Device Pairing Code

4. Enter the Quantum pairing code, `faro`, and click **Next** to create the SPP connection.

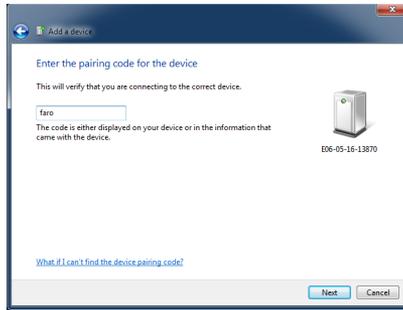


Figure 3-14 Enter Device Pairing Code

5. Windows checks and installs the hardware drivers. When this is complete, click the **Devices and Printers** link.

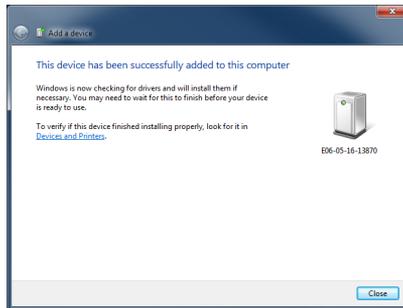


Figure 3-15 Hardware Install Complete

6. Right-click on your Quantum device and choose **Properties**.

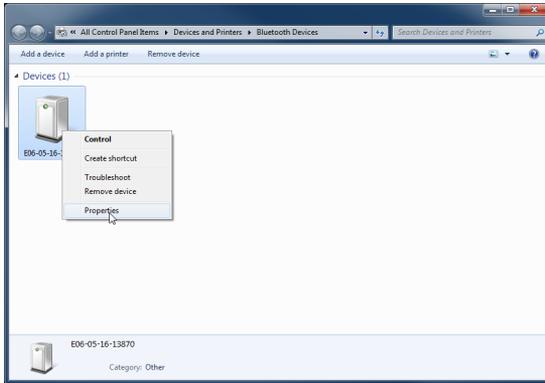


Figure 3-16 Quantum Device Properties

7. Click the **HARDWARE** tab, and look to see what COM port is assigned to your Quantum. This is usually COM3.

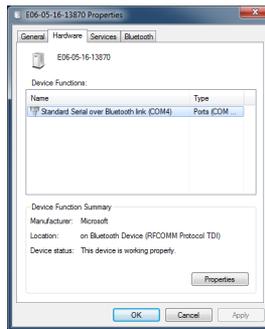


Figure 3-17 Quantum COM Port

Write down your SPP connection COM port: _____

This number is important and you will use it later.

8. Click **OK** to close the PROPERTIES dialog box.

The FaroArm driver connects to the SPP connection using the **FaroArm Manager**.

FaroArm Manager

The FaroArm driver connects to the SPP connection using the **FaroArm Manager** utility software. To connect your Quantum using Bluetooth:

1. Click **Start > FARO > FaroArm Manager**.

2. Choose **Bluetooth**.

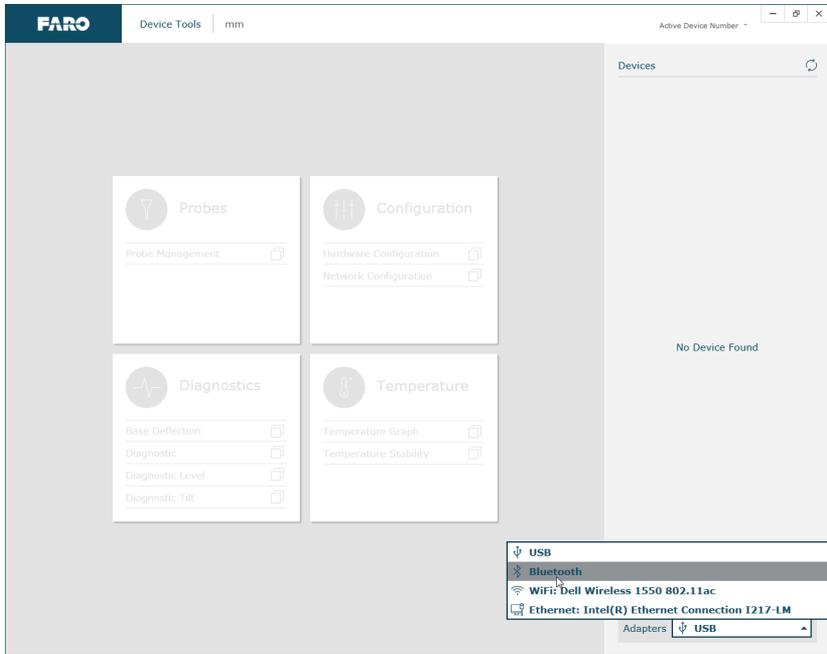


Figure 3-18 Choose the Bluetooth Connection

3. In the Devices list, click your Quantum.

NOTE: No more than two (2) Quantum pairings can be active at any one time, but any number can be defined.

When the measuring software is launched (CAM2 Measure, Geomagic, Polyworks, etc.) the FaroArm driver attempts to use any Quantum connection - USB cable and any active Bluetooth pairings. It takes slightly longer, 8 or 10 seconds, for the Quantum to connect and initialize via Bluetooth.

Once you start measuring using a hard probe, there is no difference in data transfer between using the Bluetooth connection or the USB cable. The Bluetooth connection will not support Laser Line Probe use.

FARO Wireless - WLAN

The Quantum is a Wireless Local Area Network (WLAN) equipped device and can connect to your computer without using a cable.

A WLAN is a series of interconnected computers that communicate with each other over the air waves rather than through a network cable connected to each computer. In a WLAN, a radio communications device called an access point, or wireless router, connects network computers and provides network access. The access point, or wireless router, and the wireless network card in the computer communicate by broadcasting data from their antennas over the air waves.

The Quantum WLAN is normally configured as a DHCP Client. Due to the nature of an open air system, network security is very important.

After connecting the Quantum to the computer, start the FaroArm Manager program and choose WLAN in the **Devices** group. *For more information, see “WLAN” on page 53.*

For a detailed description of the Quantum’s wireless ethernet communication, *See “WLAN Primer” on page 129.*

FaroArm Manager

The FaroArm Manager is an application to control the Quantum settings and operation. Many measuring applications will directly connect and use sections of this application while connected to your Quantum.

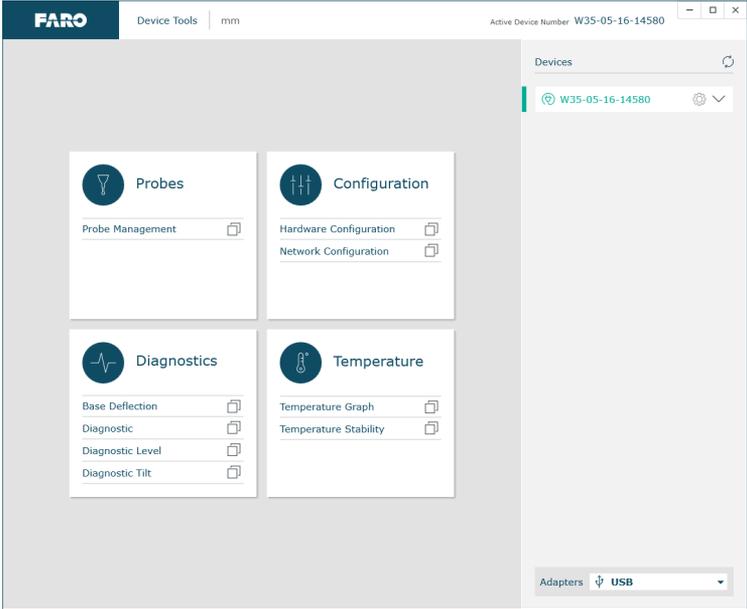


Figure 3-19 FaroArm Manager

Devices

The **Devices** group controls the connection settings between your Quantum and your computer.

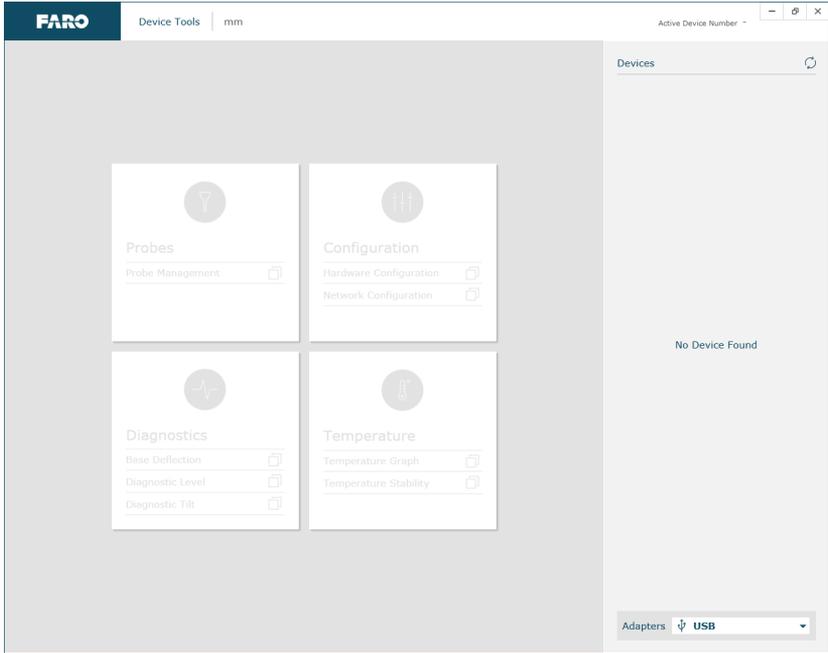


Figure 3-20 Connecting a Quantum

In the ADAPTERS drop-down list, choose the type of connection:

- USB
- Bluetooth
- WLAN
- Ethernet

USB

Choose USB if your connection is using a USB cable. Your Quantum will appear at the top of the DEVICES list. If necessary, click the REFRESH button to search the computer for your Quantum.

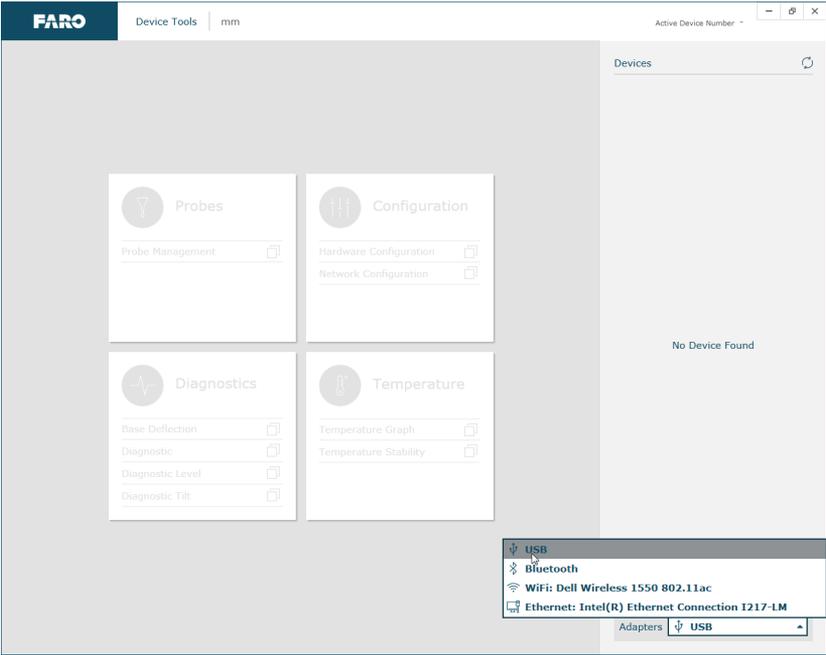


Figure 3-21 USB Connection

- Click your Quantum to make it the active device.



Figure 3-22 Choosing the Active Device

Bluetooth

Choose BLUETOOTH if your connection is using the Bluetooth wireless connection. Your Quantum will appear at the top of the DEVICES list. If necessary, click the REFRESH button to search the computer for your Quantum.

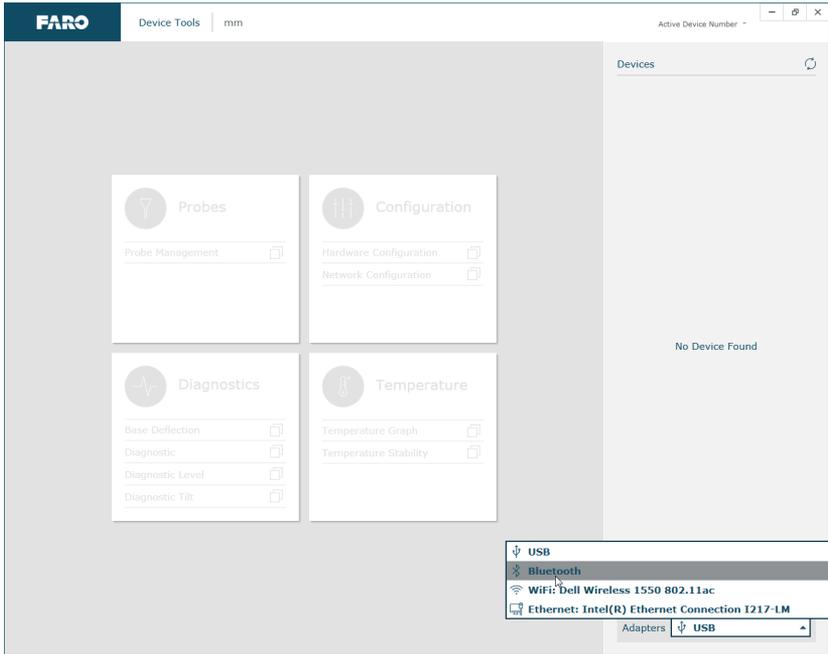


Figure 3-23 Bluetooth Connection

NOTE: Ensure the Quantum’s Bluetooth On/Off button is on and your computers wireless receiver is on.

- Click your Quantum to make it the active device.



Figure 3-24 Choosing the Active Device

WLAN

Choose WiFi if your connection is using the wireless ethernet connection. Your Quantum will appear at the top of the DEVICES list. If necessary, click the REFRESH button to search the computer for your Quantum.

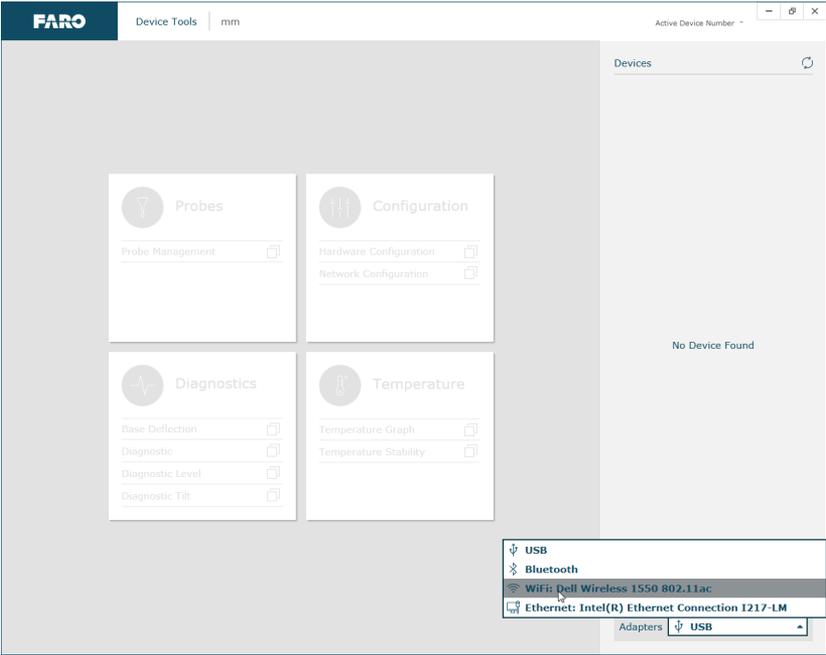


Figure 3-25 WLAN Connection

NOTE: Ensure the Quantum’s WLAN On/Off button is on and your computers wireless receiver is on.

- Click your Quantum to make it the active device.



Figure 3-26 Choosing the Active Device

There are two WLAN settings depending on your wireless hardware configuration. The default setting is WLAN to PC/Laptop. For more information, see “Network Configuration” on page 77.

Ethernet

Choose ETHERNET if your connection is using an Ethernet cable. Your Quantum will appear at the top of the DEVICES list. If necessary, click the REFRESH button to search the computer for your Quantum.

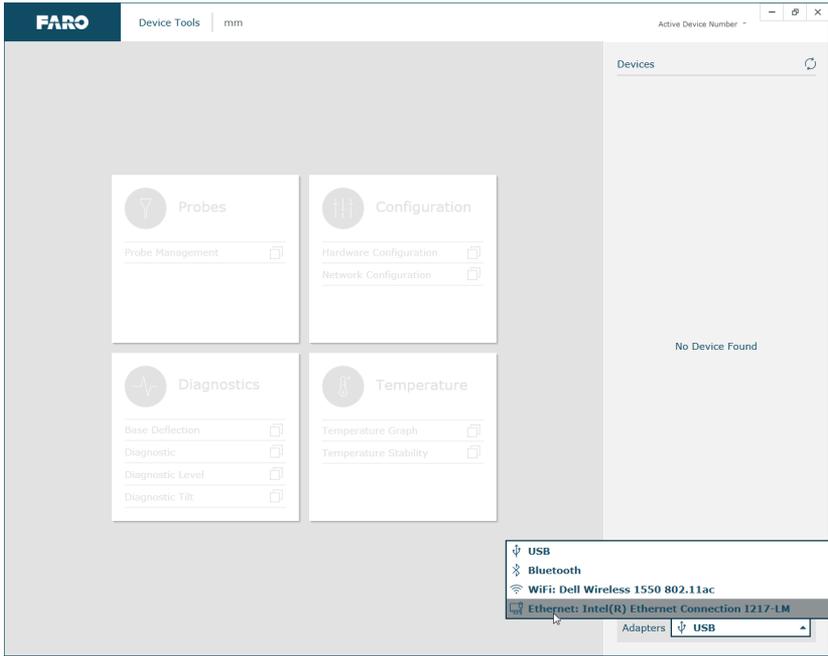


Figure 3-27 Ethernet Connection

- Click your Quantum to make it the active device.



Figure 3-28 Choosing the Active Device

Probes

The **Probes** group controls your Quantum's probe selection and settings.

Probe Management

Click **Probe Management** to change and edit a probe. In the PROBE MANAGEMENT dialog box you can:

- Select the current probe and view the COMPENSATION STATUS.
- Create, Edit or Delete, or Duplicate a probe.
- Compensate the current probe.
- View the compensation log for the current probe.
- Start the Single Point Articulation Test (SPAT).
- Run an Arm Compensation or reset to the FARO Factory Arm Compensation.

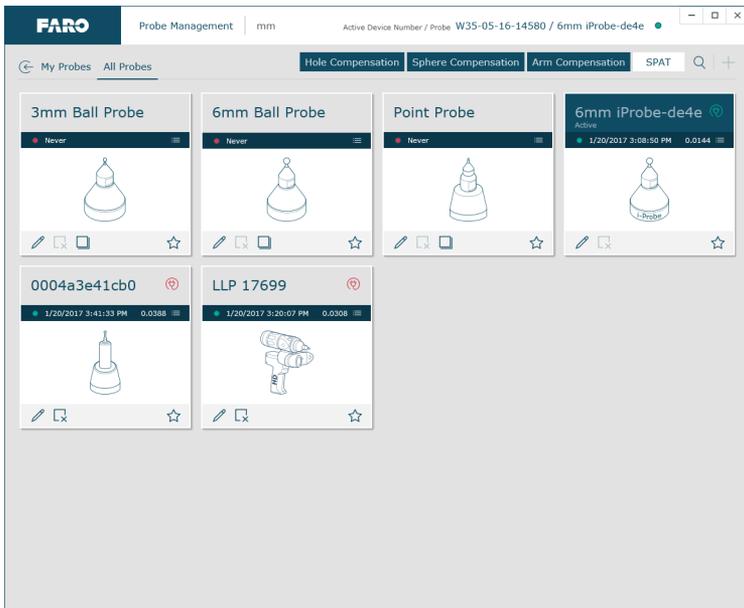


Figure 3-29 Probes dialog box

The COMPENSATION STATUS and compensation date display for every probe. The four standard probes for the Quantum (3 mm, 6 mm, Point and FARO Laser Line Probe) are created by default.



Figure 3-30 Probe Information

NOTE: If you do not see all of the probes, click **Find** to search the Quantum and your computer.

Compensate each of these probes before you begin measuring your parts. See “Probe Compensation Overview” on page 58 and “Probe Compensation” on page 59

Click the list to show the most recent compensations.



Figure 3-31 Compensation List

- Click **View All** to see the Compensation Log. See “View Log” on page 74. Click **SPAT** to run a Single Point Articulation Test (SPAT) with your Quantum. 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 138.

Click **Arm Compensation** to create a user arm compensation for your Quantum. For more information, see “User Compensation” on page 139.

Click **Add** to add a new probe. See “Edit Probe” on page 57.

NOTE: You can also select any probe and click **Duplicate** to create another probe.

Using FARO i-Probes

The standard 3 mm and 6 mm probes are FARO i-Probes. The exact diameter is electronically recorded on the i-Probe. You do not need to edit any parameters of the standard Quantum i-Probes.

NOTE: This generation of FARO i-Probe will not attach to the FaroArm Edge, Platinum, or Fusion. Installing the i-Probe to anything other than the FaroArm Quantum damages the i-Probe. Previous generations of the FARO i-Probe will not attach to the Quantum.

Edit Probe

Select any probe and click **Edit** to modify the details of the current probe.



Figure 3-32 Editing a Probe

Modify any settings and click **Save** to continue.

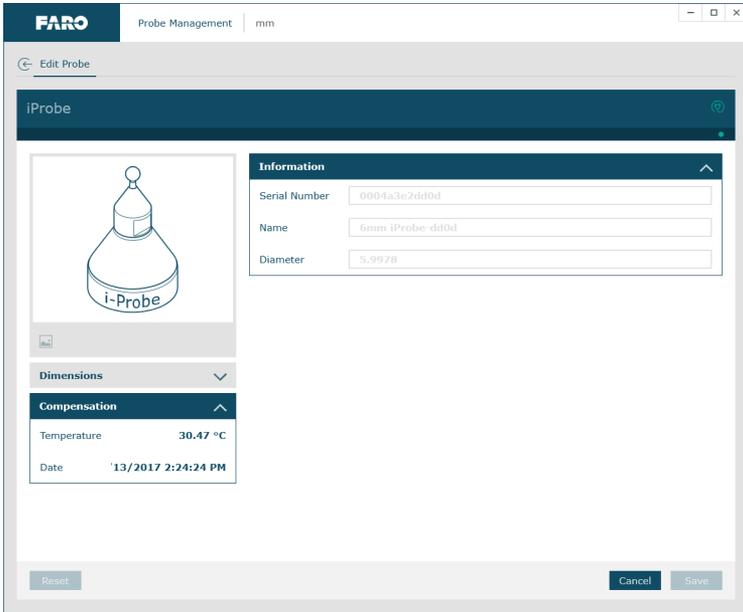


Figure 3-33 Modify Probe dialog box

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 Quantum's reference system. The Quantum 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 Quantum. The last axis of the Quantum 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 Quantum 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.



Figure 3-34 Probe Compensation

To optimize compensation and minimize stress-induced errors during this critical procedure, place the Quantum 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 Quantum for the software to accurately compensate the probe tip. To maximize accuracy, minimize elbow joint movement and focus on the probe and last arm joint during compensation.

Probe Compensation

When changing the style or dimension of the probe at the end of the Quantum, you must compensate it for the Quantum 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. The Sphere Compensation method differs for 6-Axis and 7-Axis models.

- See “Hole Compensation Method - Guidance” on page 60.
- See “Hole Compensation Method” on page 63.
- See “Sphere Compensation Method - 6-Axis” on page 67.
- See “Sphere Compensation Method - 7-Axis” on page 70.

Hole Compensation 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.

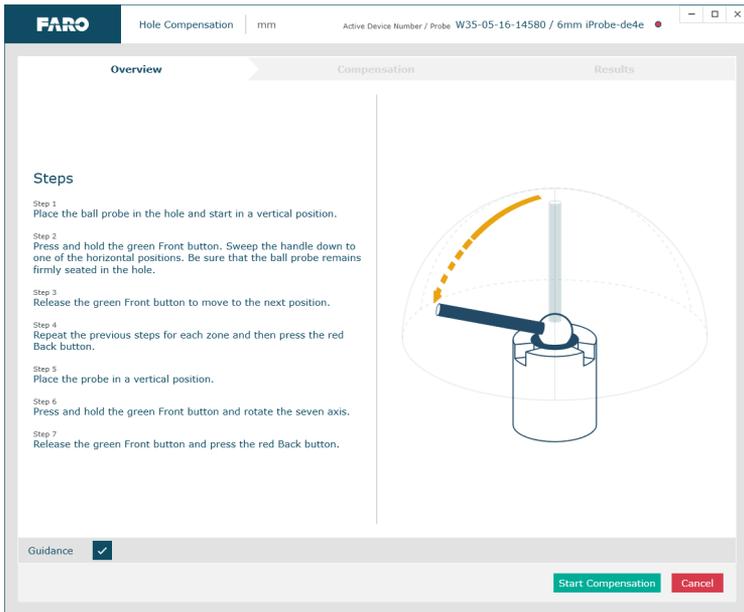


Figure 3-35 Hole Compensation with Guidance

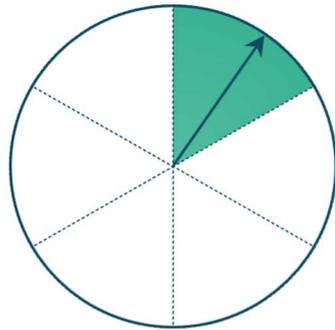
Collect all of the points in this method by holding down the green **Front** button. The Quantum will collect points as fast as possible (“scanning”) until you release

the green **Front** button. Digitize at least 200 points in each of the ten different sweep positions.

1. Place the ball probe in the compensation cone. Start in a vertical position.



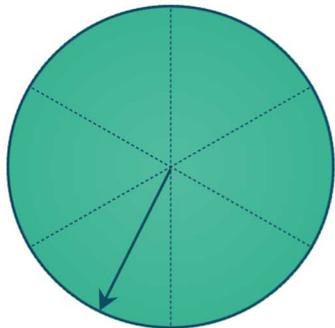
2. Press and hold the green **Front** button and move the handle down until the shaft of the probe is parallel with the top of the cone.
 - Sweep back up and down until the minimum amount of points are digitized.



3. Release the green **Front** button and move to the next position.

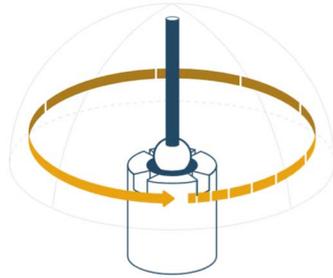
NOTE: To remove any unwanted points, press and hold the red **Back** button.

4. Repeat steps 2 and 3 for the remaining five positions.



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

5. Digitize points in the hole and rotate the handle to position #4.



6. Press the red **Back** button to finish.

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 Quantum.

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.

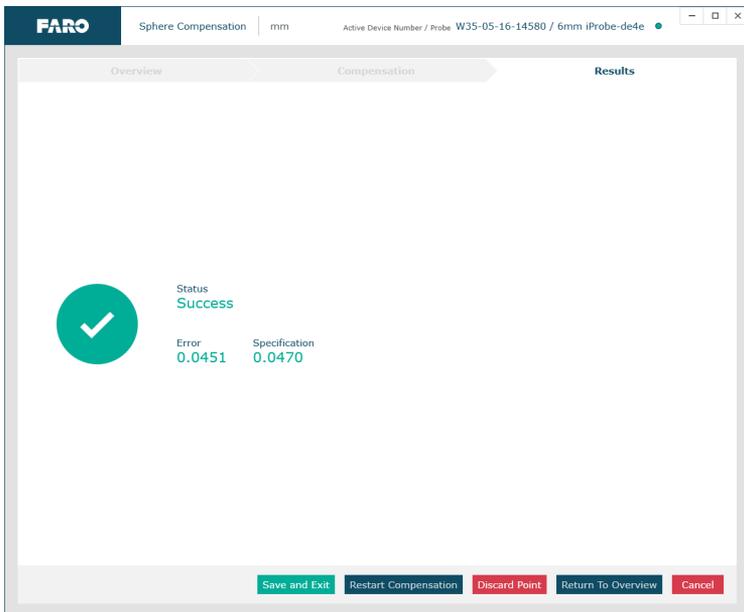


Figure 3-36 Hole Compensation Results

Hole Compensation Method

Perform the Hole Compensation using the FARO probe compensation cone or a 5 mm diameter machine drilled hole. The hole does not have to be exactly 5 mm, but it must be smaller than the probe's diameter and have a smooth seat.

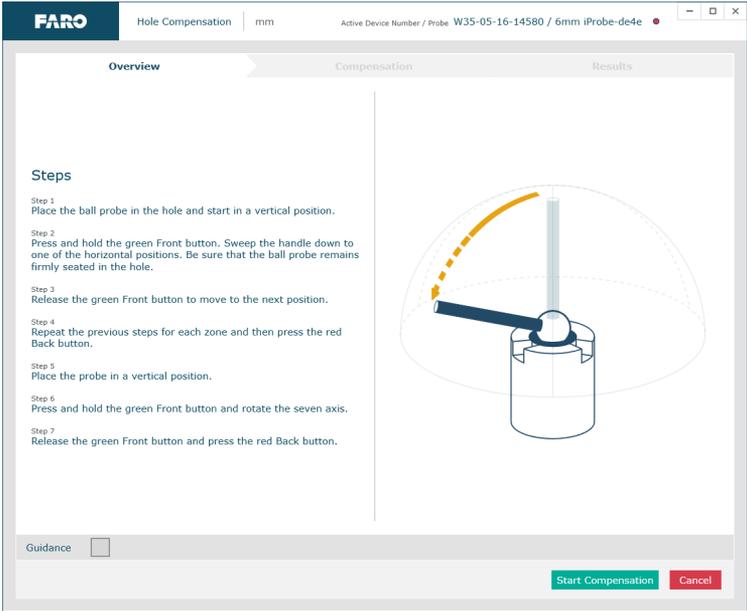


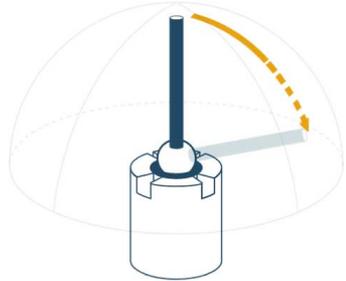
Figure 3-37 Hole Compensation

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

1. Place the ball probe in the compensation cone. Start in a vertical position.



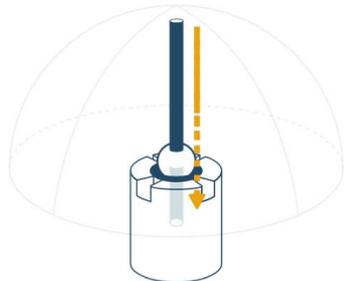
2. Digitize points in the compensation cone and sweep to position #1.
 - Press and hold the green **Front** button and move the handle down until the shaft of the probe is parallel with the top of the cone.



3. Release the green **Front** button and move to the next position.

NOTE: To remove any unwanted points, press and hold the red **Back** button.

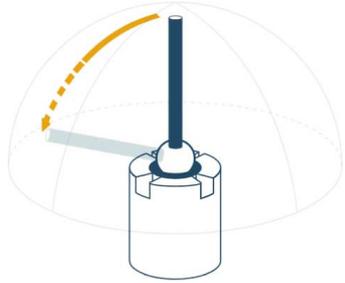
4. Digitize points in the compensation cone and sweep to position #2.
 - Press and hold the green **Front** button and move the handle down until the shaft of the probe is parallel with the top of the cone.



5. Release the green **Front** button and move to the next position.

6. Digitize points in the compensation cone and sweep to position #3.
 - Press and hold the green **Front** button and move the handle down until the shaft of the probe is parallel with the top of the cone.

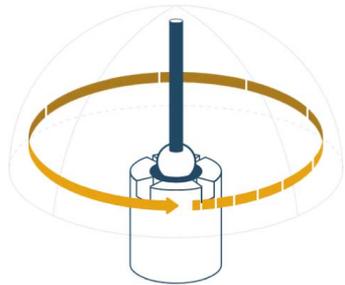
NOTE: You must digitize at least 150 points.



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

7. Digitize points in the compensation cone and rotate the handle.
 - Press and hold the green **Front** button and rotate the handle.

NOTE: You must digitize at least 50 points in this position.



8. Press the red **Back** button to finish.

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 Quantum.

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.

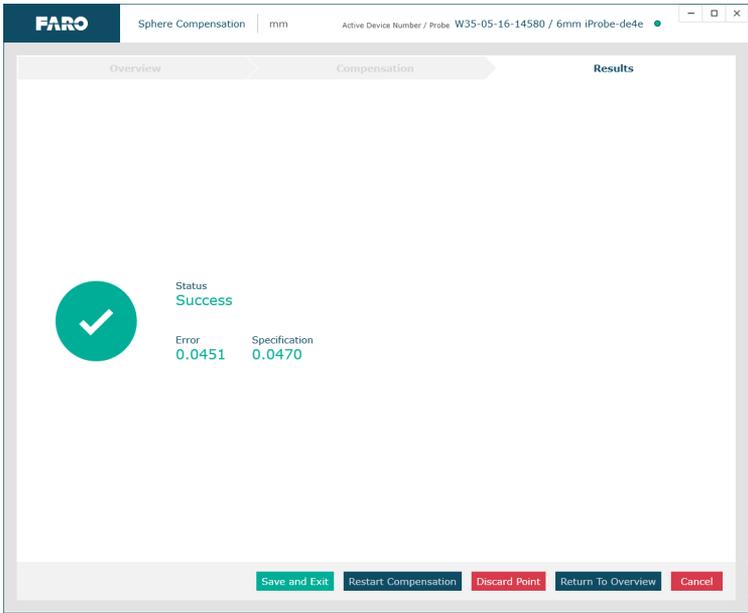


Figure 3-38 Compensation Results

Sphere Compensation Method - 6-Axis

Perform the Sphere Compensation using a precision sphere or tooling ball. The sphere should be at least 10 mm (3/8 in) diameter or larger. You will digitize 45 individual points in three specific locations around the sphere by pressing the green **Front** button for each.

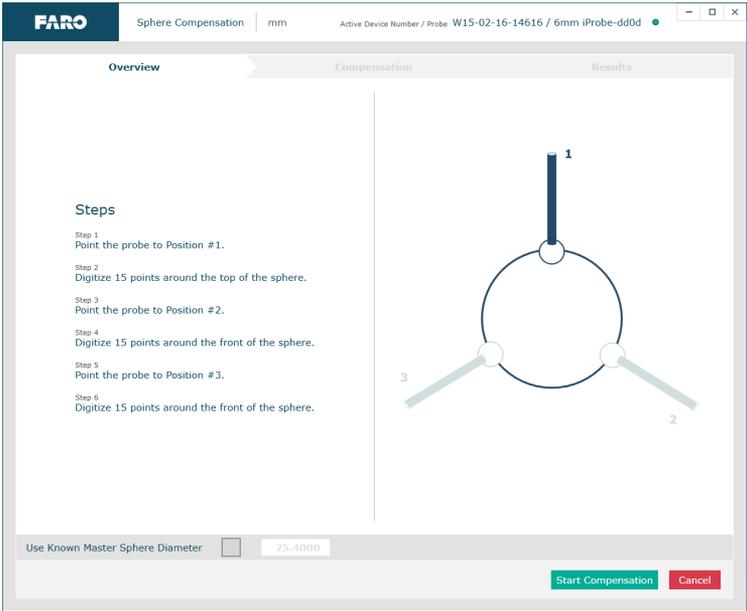
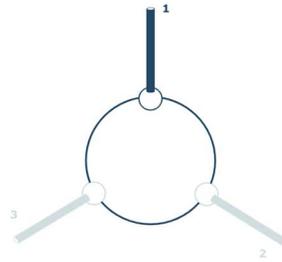


Figure 3-39 6-Axis Sphere Compensation

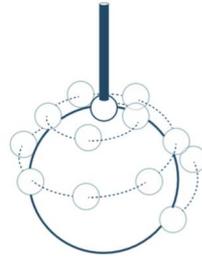
CAUTION: The ball probe *must* remain in contact with the sphere while digitizing points. Even one or two poorly digitized points significantly

affects the optimization process, which then has an effect on the accuracy of the Quantum.

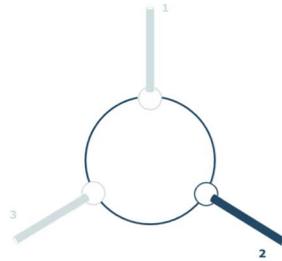
1. Move the handle so that the probe is pointing in position #1.



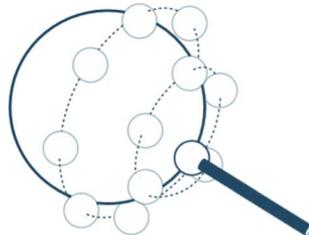
2. Digitize 11 points around the top hemisphere of the sphere with the probe pointing in position #1. Hold the handle in the same direction and orientation for every point.



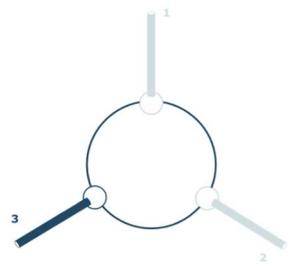
3. Move the handle so that the probe is pointing in position #2.



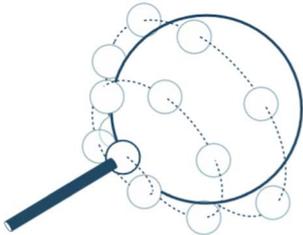
4. Digitize 11 points around the top hemisphere of the sphere with the probe pointing in position #1. Hold the handle in the same direction and orientation for every point.



- 5. Move the handle so that the probe is pointing in position #3,



- 6. 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.

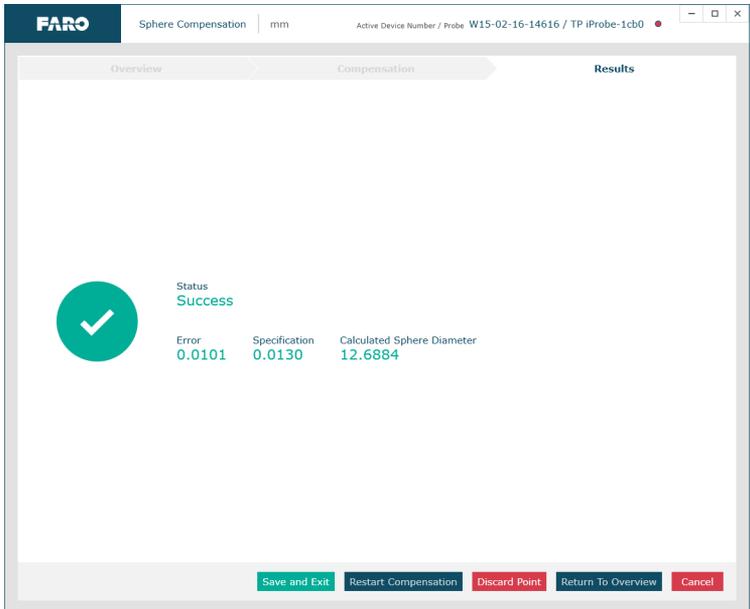


Figure 3-40 6-Axis Sphere Compensation Results

Sphere Compensation Method - 7-Axis

Perform the Sphere Compensation using a precision sphere or tooling ball. The sphere should be at least 10 mm (3/8 in) diameter or larger. You will digitize 44 individual points in two specific locations around the sphere by pressing the green **Front** button for each.

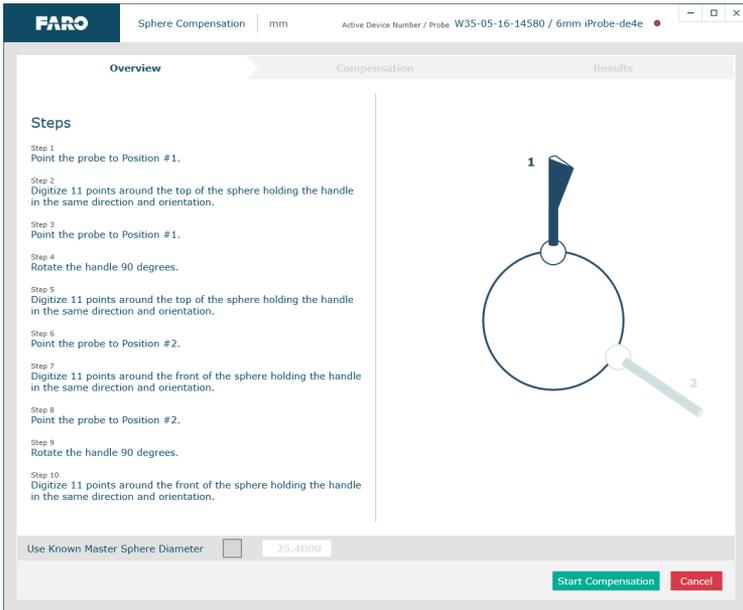


Figure 3-41 7-Axis Sphere Compensation

CAUTION: The ball probe *must* remain in contact with the sphere while digitizing points. Even one or two poorly digitized points significantly

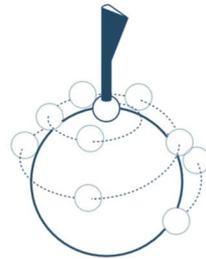
affects the optimization process, which then has an effect on the accuracy of the Quantum.

1. Move the handle so that the probe is pointing in position #1.

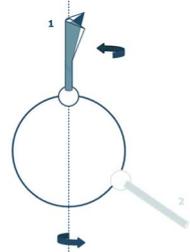


2. Digitize 11 points around the top hemisphere of the sphere with the probe pointing in position #1. Hold the handle in the same direction and orientation for every point.

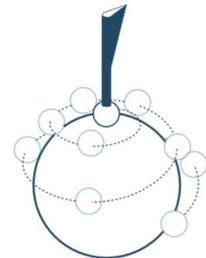
NOTE: Watch the live guides at the bottom of the screen to ensure the direction and orientation remain the same for all points.



3. Rotate the handle 90 degrees.



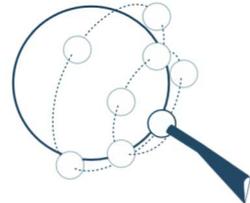
4. Digitize 11 points around the top hemisphere of the sphere with the probe pointing in position #1. Hold the handle in the same direction and orientation for every point.



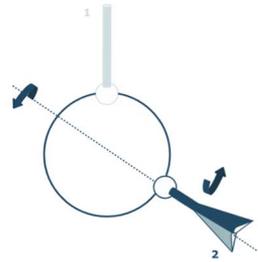
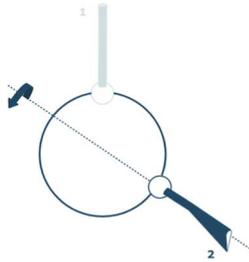
- 5. Move the handle so that the probe is pointing in position #2,



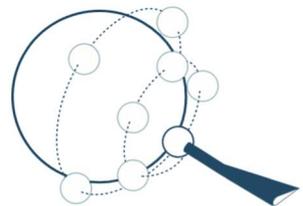
- 6. Digitize 11 points around the front hemisphere of the sphere with the probe pointing in position #2. Hold the handle in the same direction and orientation for every point.



- 7. Rotate the handle 90 degrees.



- 8. 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.

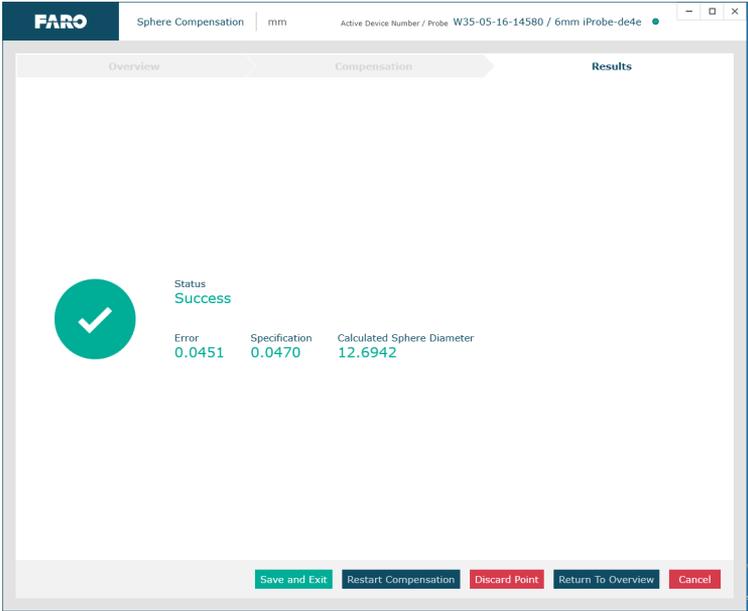


Figure 3-42 7-Axis Sphere Compensation Results

View Log

The MANAGE COMPENSATION dialog box displays the compensation history of the current probe. You can set to active or delete any previous compensation. You can also copy the compensation values to the Windows clipboard.

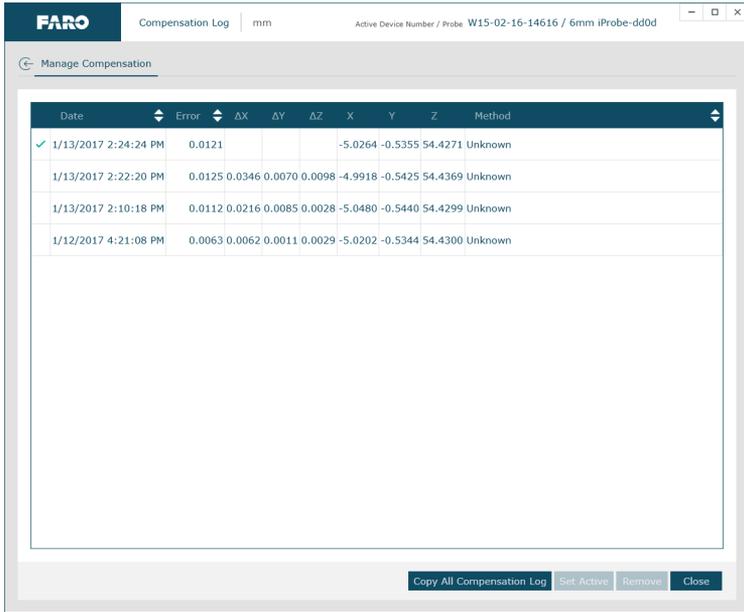


Figure 3-43 Compensation Log dialog box

The previous probe compensations are compared to the current probe:

- The ΔX , ΔY , ΔZ values are the location of the center of the ball probe in the last joint coordinate system compared to the current probe compensation.

- The 2 Sigma Error value is the deviation of all the points taken during the compensation. In order to pass compensation, this value has to be less than the single point accuracy specification of the Quantum.

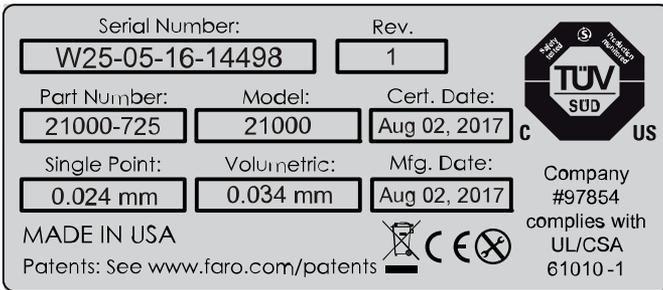


Figure 3-44 Quantum Accuracy Label

- Select any probe compensation and click **Set Active** to switch to that compensation.
- Select any probe compensation and click **Remove** to delete that compensation.

Configuration

The **Configuration** group controls your Quantum’s general hardware and advanced connection settings.

Hardware Configuration

In the HARDWARE CONFIGURATION dialog box you can:

- View the current information about the Quantum.
- Enable/disable Stress Stops and adjust the sensitivity. See “*Error and Status Indicators*” on page 37.
- Set the arm controlled mouse settings.

Click **Save** to accept the changes. Click the **Cancel** button to discard any changes and exit the command.

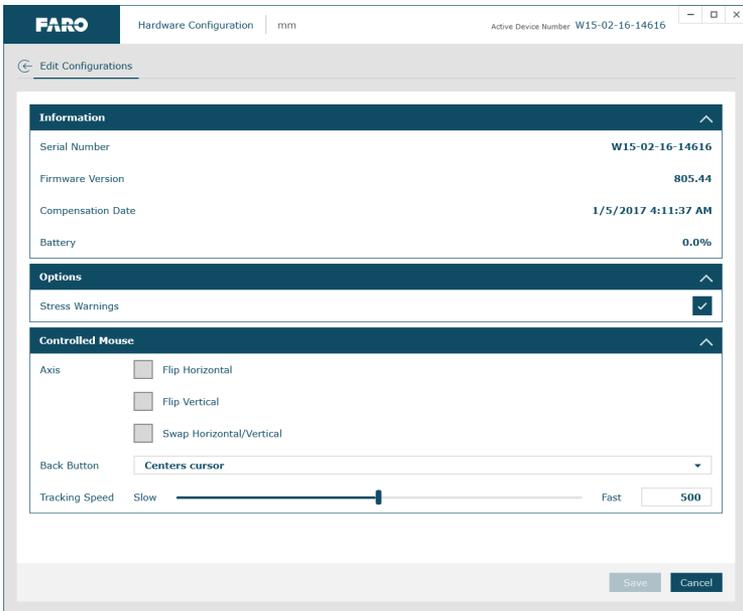


Figure 3-45 Hardware Configuration dialog box

Stress Warnings: Clear this check box to disable the stress warnings.

FaroArm Controlled Mouse: The axis 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** (Red) button. These options are ignored during any measurement command.

- Centers Cursor - move the cursor to the center of the screen.
- As Right Mouse Button - sends a right mouse button command to the computer.
- As Center Mouse Button - sends a center mouse button command to the computer.
- 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 CAM2 Measure.

Tracking Speed: Adjust the speed of the cursor is adjusted using the TRACKING SPEED slider. Move the slider to the left to decrease, and to the right to increase the tracking speed. You can also enter a value between 0 and 1000 in the field to the right of the slider.

Network Configuration

In the NETWORK CONFIGURATION dialog box you can:

- Enable/Disable the Bluetooth transmitter.
- Enable/Disable the WLAN transmitter and change settings.
- Change the Ethernet settings.

Click **Close** to exit.

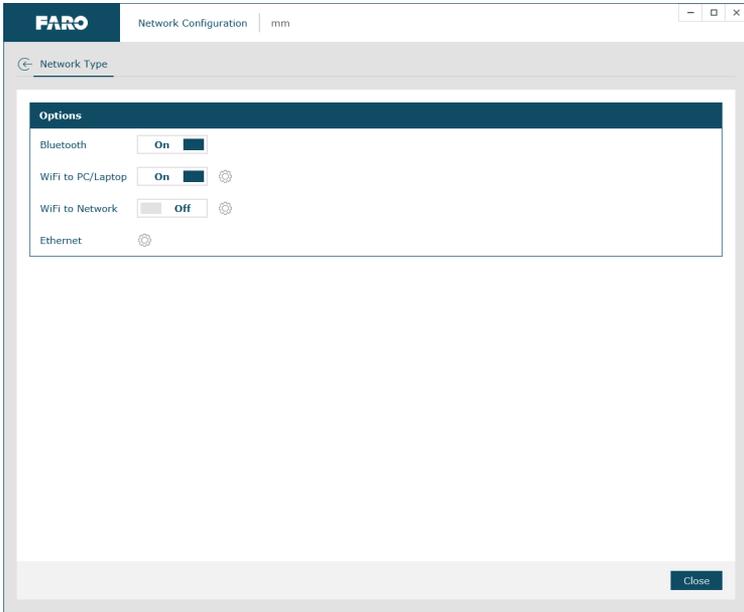


Figure 3-46 Network Configuration dialog box

Click the settings button next to each connection type to change the connection settings.

Diagnostics

The **Diagnostics** group controls is a set of commands for checking your Quantum's setup and general operation.

Base Deflection

Click BASE DEFLECTION to run a test the physical setup of your Quantum. If this test fails, run Diagnostic Tilt command to test for any tilt in the base of the Quantum.

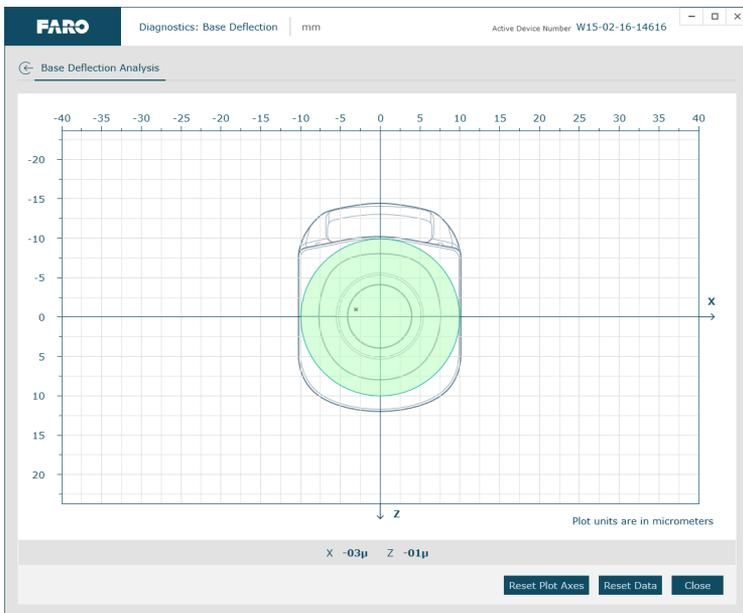


Figure 3-47 Network Configuration dialog box

1. Set up the FARO compensation cone approximately $\frac{2}{3}$ of the Quantum's reach away from its base.
2. Place a properly compensated probe firmly in the cone.
3. Click **Reset Data** to begin the test.
4. Press the green **Front** button and move the tubes and joints of the Quantum while keeping the probe firmly seated in the cone.
NOTE: Press the green **Front** button to reset the screen at any time.
5. Press the red **Back** button to stop.

6. Any deflection of the base is recorded and displayed on the screen. All of the points must be within the circle on the graph.
 - Rotate the mouse wheel to zoom in and out of the chart. Right-click and drag to move the chart around the window.
 - Click RESET PLOT AXES or double-click the wheel button to reset the chart view.
7. Click **Close** to exit.

Diagnostics

Click DIAGNOSTICS to see the operation if your Quantum’s internal components.

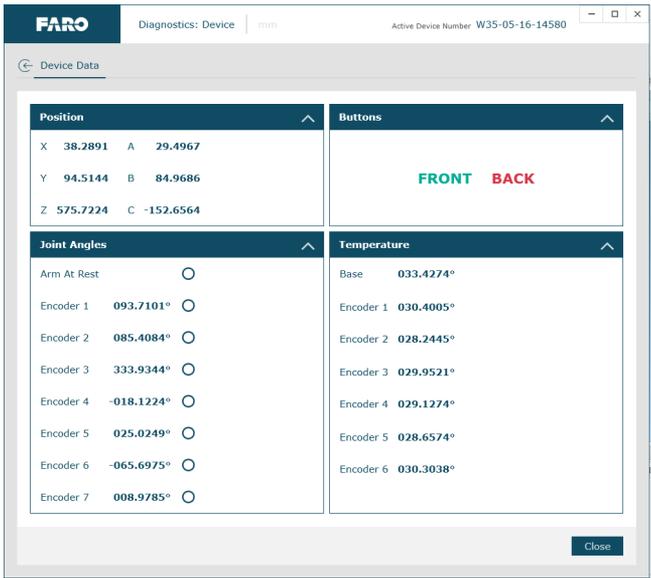


Figure 3-48 Diagnostics dialog box

Diagnostic Level

Click **DIAGNOSTIC LEVEL** to compare the Quantum to level. This command uses the Quantum's internal inclinometer. The Quantum should never lean more than $\pm 5^\circ$ from level.



Figure 3-49 Diagnostic Level dialog box

1. Look at and adjust the mounting until the white dots are centered in each bubble.
2. Click **Close** to exit.

Diagnostic Tilt

Click **DIAGNOSTIC TILT** to check for any tilt in the base of the Quantum. This command uses the Quantum's internal inclinometer.

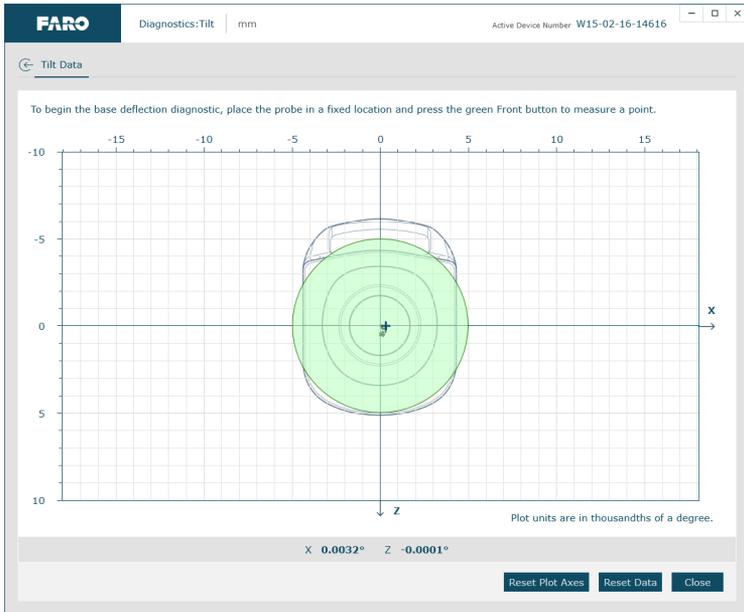


Figure 3-50 Diagnostics dialog box

1. Move the tubes and joints of the Quantum.
 - Any tilt of the base is recorded and displayed on the screen. All of the points must be within the circle on the graph.
 - Click **Reset** to clear the screen.
 - Rotate the mouse wheel to zoom in and out of the chart. Right-click and drag to move the chart around the window.
 - Click **RESET PLOT AXES** or double-click the wheel button to reset the chart view.
2. Click **Close** to exit.

Temperature

The **Temperature** group controls is a set of commands for checking your Quantum's internal temperature.

Temperature Graph

Click TEMPERATURE GRAPH to view the recorded temperature of the Quantum over a long period of time.

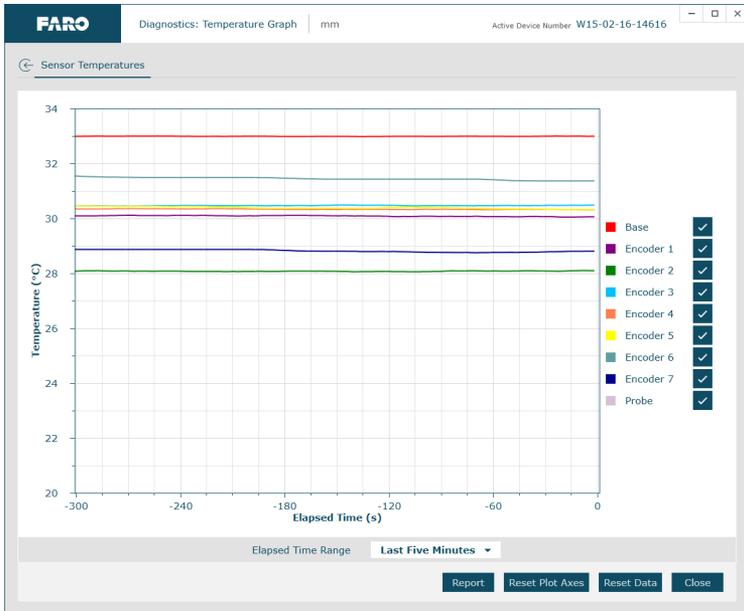


Figure 3-51 Temperature Graph dialog box

- Rotate the mouse wheel to zoom in and out of the chart. Right-click and drag to move the chart around the window.
- Click RESET PLOT AXES or double-click the wheel button to reset the chart view.
- Click on any line to see the details.
- Choose a time range from the ELAPSED TIME RANGE drop-down list.
- Clear the ENCODER check box to remove it from the chart.
- Click REPORT to generate a report file (*.csv) of the chart.
- Click RESET DATA to clear all temperature data and restart the temperature measurement.

Temperature Stability

Click TEMPERATURE GRAPH to view the ambient temperature change of the Quantum over time.

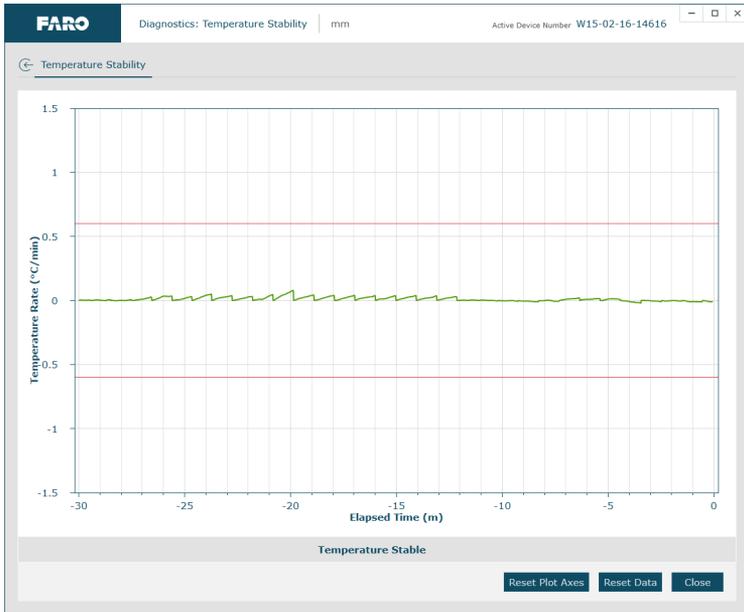


Figure 3-52 Temperature Stability dialog box

- Rotate the mouse wheel to zoom in and out of the chart. Right-click and drag to move the chart around the window. Double-click the wheel button to reset the chart view.
- Click RESET PLOT AXES or double-click the wheel button to reset the chart view.
- Click on the line to see the details.
- Click RESET DATA to clear all temperature data and restart the temperature measurement.

Notice the ambient temperature for the Quantum. Check that ambient temperature is not fluctuating more than 3°C (5.4°F) over a five minute period.

Chapter 4: Probes

This chapter describes the standard Quantum probes and optional probes for specialty measurement. The Quantum collects data by touching the part with a probe attached to the end of the handle. You can install a variety of probes on your Quantum. *For more information, see “Installing Probes” on page 19.*

NOTE: Once the probe is attached, it must be compensated. *See “Probe Compensation” on page 59.*

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Quantum Ball Probes

The Quantum uses the FARO i-Probe. This is an electronically serialized intelligent probe that automatically provides its actual *exact* ball diameter to the Quantum and monitors probe body temperature to compensate for thermal deformation.



Figure 4-1 Quantum Probes

NOTE: Quantum probes will not attach to any earlier FaroArm models. Probes from earlier FaroArm models will not attach to the Quantum without an optional adapter.

The Quantum's point of measurement on any ball probe is the center of the ball. Third-party feature measurement or quality control software compensates for the radius of the ball probe. Point probes are only recommended when the software will not compensate for the radius of the ball probe. The point probe has an impact on measurement accuracy. The error depends on:

- The width of the point on the probe.
- The position and placement of the point on the object.

Before measuring with the Quantum the probe must be compensated. Use the **Probes** command in your measuring software, to set up and compensate the probe.

For more information, see "Probes" on page 55.

NOTE: All FARO i-Probes have a unique serial number. After compensating an i-Probe, the compensation information stores on your computer. If you remove the i-Probe and reinstall it later, the Quantum automatically loads the compensation data.

Custom Probes

You can create any size probe to attach to the Quantum.

- The Quantum probe thread size is 1.40” - 32 UNS - 2B.
- The base of the probe should follow the shape of the FARO probes.
- The custom probe will thread onto the end of the handle and tighten with a 12 mm wrench.

Your custom probe should be as rigid as possible. Any deflection in the probe will add inaccuracy to the Quantum system.

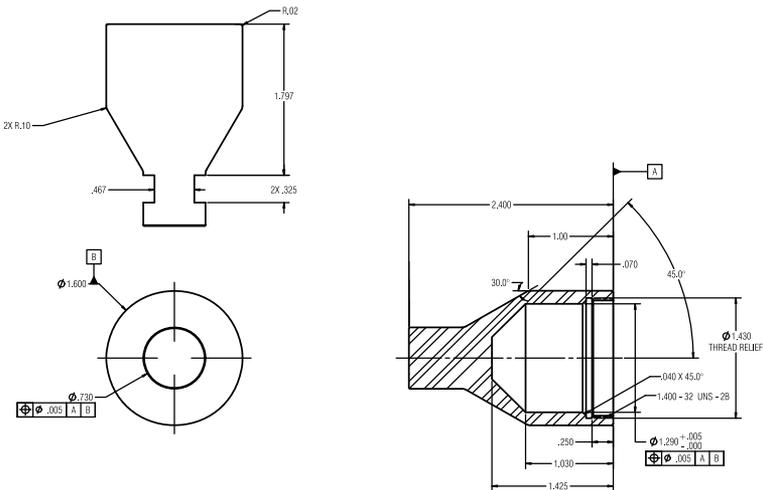


Figure 4-2 Custom Probe Dimensions

The ball probe diameter must be measured and entered in the probe settings section of the software. To enter the exact diameter value:

- In your measuring software (CAM2 Measure, Geomagic, Polyworks, etc.), edit the diameter of the custom probe. Enter the exact diameter in the EDIT PROBE dialog box for each ball probe. See “Edit Probe” on page 57.

NOTE: FARO Technologies, Inc. does not guarantee the accuracy of the Quantum with the use of a custom probe.

FARO Laser Line Probe HD

The FARO Laser Line Probe HD is a non-contact probe that collects digitized points using a line of projected laser light and a camera. The laser light is projected onto your part as a line, the camera takes a picture of the shape and position of the line, and several points are then sent to the computer. This is done many times in a second to quickly measure curved surfaces, or surfaces that can not be measured using a standard ball probe.



Figure 4-3 FARO Laser Line Probe HD

NOTE: The FARO Laser Line Probe only connects to a 7-Axis Quantum.

Computer Requirements

The FARO Laser Line Probe will generate thousands of points in a short amount of scanning time. For best results, your computer must have a powerful Central Processing Unit (CPU) and a large amount of Random Access Memory (RAM). FARO recommends the following:

CPU - Intel i7 with 4 Cores (Quad Core)

RAM - 8GB minimum, 32 GB recommended

NOTE: Connect the Quantum to the computer using the USB cable. The Ethernet, WLAN, or Bluetooth connections do not support the data rates of the FARO Laser Line Probe.

Laser Safety

All FARO Laser Line Probe models produce a visible laser beam. The laser is CDRH Class II and IEC Class 2M power level; however operation of the device requires the operator to avoid direct exposure to eyes at all times.

You should avoid direct exposure to your eye at all times. Although the human blink reaction to bright light provides a natural mechanism of protection to this visible laser beam, use caution while handling the FARO Laser Line Probe by pointing it at only the target object.

CAUTION: USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS LASER LIGHT EXPOSURE.

Laser Radiation Emission

When the FARO Laser Line Probe is operating, a laser beam emits from the aperture at the front of the FARO Laser Line Probe. See Figure 4-4 for the location of the laser beam aperture.



Figure 4-4 Laser Aperture

When the laser is operating, the Quantum Handle LED illuminate. Figure 4-5 identifies the location of the laser emission indicator.

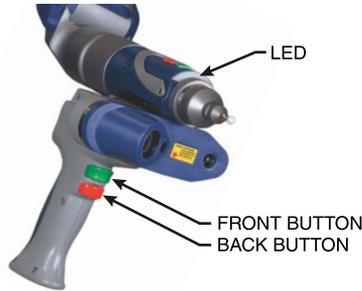


Figure 4-5 Laser Emission Indicator

The LED also indicates the range of the laser to the target surface. *For more information, see “Range Finder Dialog Box” on page 96.*

CAUTION: VIEWING THE LASER OUTPUT WITH CERTAIN OPTICAL INSTRUMENTS (EYE LOUPES, MAGNIFIERS, AND MICROSCOPES, ETC.) WITHIN A DISTANCE OF 100 MM MAY POSE AN EYE HAZARD.

FARO Laser Line Probe HD

Laser power up to 18 mW at 450 nm in a diverging beam could be accessible in the interior of the FARO Laser Line Probe.

WARNING: DO NOT ATTEMPT TO OPEN THE FARO LASER LINE PROBE CASE. THERE ARE NO USER-SERVICEABLE PARTS.

Serial Number Label

The FARO Laser Line Probe Serial Number label contains the serial number, laser information, calibration, warning logotype and manufacturing date. See Figure 4-4 for the location of the laser beam aperture.



Figure 4-6 Serial Number Label

Servicing

The FARO Laser Line Probe should only be serviced by FARO Customer Support technicians.

CAUTION: There are no user serviceable parts in this device. *DO NOT* attempt to open the casing or disassemble the device at any time.

If the FARO Laser Line Probe is not operating properly, contact FARO Customer Support. If it has malfunctioned, power down the system, remove it from the Quantum and return it to FARO Customer Support for repair.

WARNING: DO NOT ATTEMPT TO OPEN THE FARO LASER LINE PROBE CASE. THERE ARE NO USER-SERVICEABLE PARTS.

Hardware Installation

The FARO Laser Line Probe is stored in a separate Shipping case. Installing it is similar to the Quantum 7-Axis Handle. See “7-Axis Handle” on page 21. The FARO Laser Line Probe *can* be attached/detached while the Quantum is powered On.

NOTE: The FARO Laser Line Probe HD does not fit into the Shipping case.

To attach the probe:

1. Set up your Quantum and install the 6 mm or 3 mm ball probe.
2. Loosen the handle locking ring by turning it counterclockwise.
3. Remove the protective cover.



Figure 4-7 Attaching the 7-Axis Handle

4. Insert the front edge of the probe into the slot.
5. Push the probe handle in so that the connectors connect.

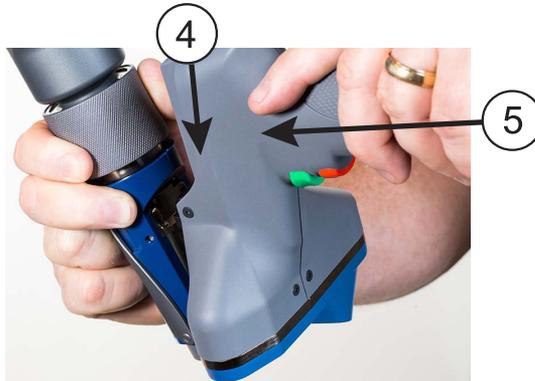


Figure 4-8 Attaching the 7-Axis Handle

6. Tighten the locking ring by turning it clockwise. Do not over-tighten the ring.

NOTE: Remove the FARO Laser Line Probe from the Quantum before packing. See “Packing the Quantum” on page 29.

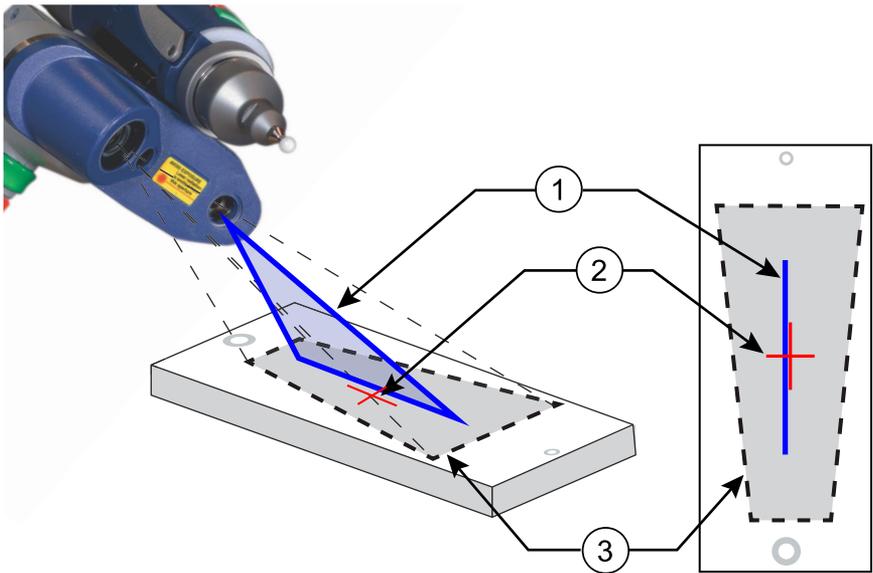
Holding the FARO Laser Line Probe

Never grab the FARO Laser Line Probe while measuring. Simply hold the pistol grip.

NOTE: Avoid touching the lenses. When necessary, clean the left and right lenses with the cloth from the FARO Laser Line Probe case. Dirt and grease on either lens can cause poor results.

Pointing to a Surface

The following figure shows the orientation of the FARO Laser Line Probe to the surface.



- ① Blue Laser Line Beam
- ② Red Range Cross Hair
- ③ Camera Field of View (FOV)

Figure 4-9 Scanning a Surface

Hardware Controls and Indicators

The FARO Laser ScanArm (Quantum with FARO Laser Line Probe) uses the green **Front** and red **Back** buttons and the Handle LEDs.

Buttons

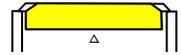
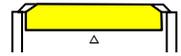
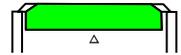
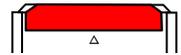
Use the buttons on the Quantum handle or the buttons on the FARO Laser Line Probe handle to control measuring.

- Use the green **Front** button to start data collection. Points are only sent to the computer when the laser is in range. Once you start collecting data, press the green **Front** button again to pause.
- Use the red **Back** button to end any measurement command.

LED

The Handle LED indicates the distance to the target object from the FARO Laser Line Probe. Remember, data is only sent to the computer when the FARO Laser Line Probe is in range.

- Out of Range (Red LED). The Laser Line Probe is too close to or too far away from the part.
- Center Range (Green LED) The Laser Line Probe is in the center of the range.
- Near Range (Yellow LED) The Laser Line Probe is in range, closer to the part.
- Far Range (Yellow LED) The Laser Line Probe is in range, farther from the part.



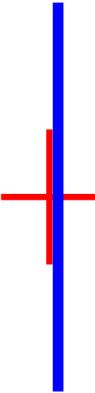
Additionally, the software uses the Range Finder Dialog Box dialog box to show the distance and position from the FARO Laser Line Probe to your part.

Range Finder

The Range Finder is an additional red cross hair that projects with the blue laser line to show you the distance from the Laser Line Probe to the surface of your part.

NOTE: The Laser Line Probe camera does not record this cross hair.

When the probe-to-part distance is in the middle of the range, the center of the cross hair and the laser line are together.



As the distance increases or decreases, the cross hair moves away from the laser line:

A vertical blue line representing the laser line. A red crosshair is positioned to the left of the blue line, indicating that the probe-to-part distance has increased.	A vertical blue line representing the laser line. A red crosshair is positioned to the right of the blue line, indicating that the probe-to-part distance has decreased.
Left as the Laser Line Probe moves farther from the surface.	Right as the Laser Line Probe moves closer to the surface.

When the Laser Line Probe is out of range, the cross hair and the laser line no longer touch.

You can switch the Range Finder off in the FARO LASER LINE PROBE CONTROL dialog box. See “FARO Laser Line Probe Settings” on page 104.

Range Finder Dialog Box

The FARO Laser Line Probe software has a RANGE FINDER dialog box. This dialog box graphically displays the probe-to-part distance and the area of the laser line that the camera is processing.

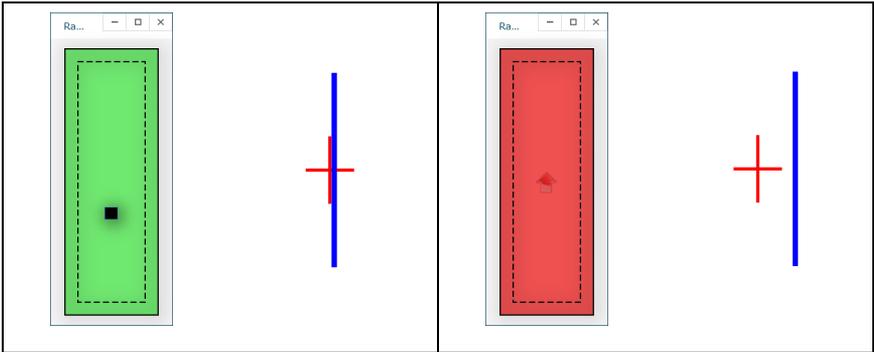


Figure 4-10 Laser Line Probe in range

Figure 4-11 Laser Line Probe not in range

When the FARO Laser Line Probe is within the operating range, the center of the target displays as a small box in the RANGE FINDER dialog box, see Figure 4-10.

The box moves as the FARO Laser Line Probe moves:

- Up - as you move the Laser Line Probe closer to your part
- Down - as you move the Laser Line Probe farther from your part
- Left - the right side of the line is in range
- Right - the left side of the line is in range

The target box changes color:

- Green - all of the laser is in range
- Orange - some of the laser is in range
- Red - none of the laser is in range

When the FARO Laser Line Probe is outside of the operating range, the target box moves to a side of the RANGE FINDER dialog box and an arrow in the center of the dialog box points to the target box, see Figure 4-11.

If the FARO Laser Line Probe is set to an *Automatic* exposure algorithm, there is an additional symbol in the upper left corner of the RANGE FINDER dialog box.

The symbol changes describes the exposure:

- Red Minus Sign (-) - low exposure
- Green Circle (O) - good exposure
- Red Plus Sign (+) - high exposure

For more information, see “FARO Laser Line Probe Settings” on page 104.

Software Setup

You can use the FARO Laser ScanArm (Quantum with FARO Laser Line Probe) with many measurement and modeling software packages. Refer to the particular application software for installation and proper use of the software with the FARO Laser ScanArm.

NOTE: Some software packages automatically add the FaroArm driver to your computer. To ensure that you have the latest version of the FaroArm driver, install the USB flash drive found inside your FaroArm case.

FARO Laser Line Probe Compensation

After you complete the installation and warm-up of the FARO Laser Line Probe and the standard probe, this system of probes must be compensated. Compensation requires measuring the FARO Compensation Plate with a standard probe and the FARO Laser Line Probe.

NOTE: When necessary, 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.

1. Open CAM2 Measure. From the DEVICE CONTROL panel, click **Probe Management** button to show the PROBES dialog box.
2. Choose a standard ball probe, 6 mm or 3 mm.

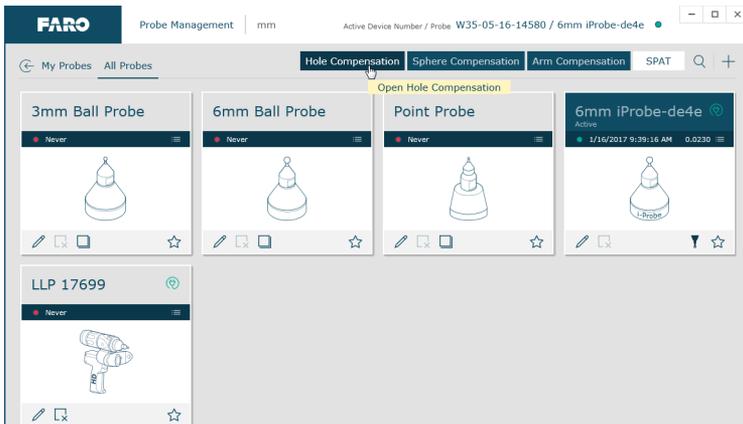


Figure 4-12 Compensating the Standard Ball Probe

3. Calibrate the standard ball probe using the single hole compensation method. See “Hole Compensation Method” on page 63.

4. Choose the Laser Probe probe.

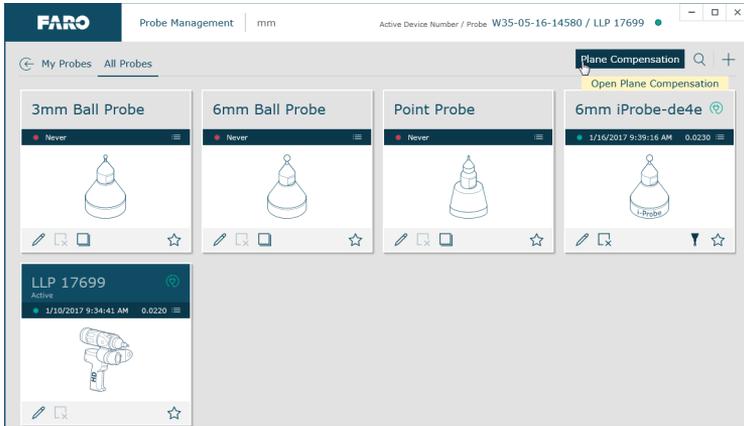


Figure 4-13 Compensating the Laser Line Probe

NOTE: Ensure that HIGH ACCURACY MODE is disabled during compensation. See “FARO Laser Line Probe Settings” on page 104.

5. Choose **Plane Compensation**.

6. Click **Measure Plane** or **Compensate LLP with Previous Values** to use the previously measured plane.

- The laser turns on and the laser beam is visible unless you are measuring the plane. After you successfully measure the plane, the laser turns on and the laser beam is visible.

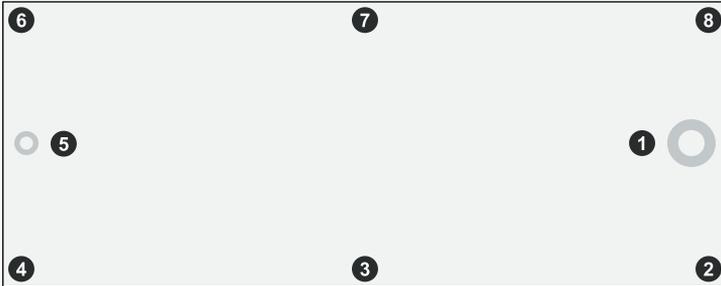
Plane Compensation

Calibrate the FARO Laser Line Probe. You will digitize the FARO Compensation Plate, once with the ball probe, and then three times with the FARO Laser Line Probe.

1. Digitize the white area of the FARO Compensation Plate with the ball probe.

- Touch the white surface with the ball probe and press the green **Front** button.
- Digitize eight points on the white surface.

NOTE: Digitize each point near an edge of the surface to avoid marring the middle of the surface.



- Pull the probe away from the surface and press the red **Back** button.

The flatness of the white surface is calculated and the results are displayed in the dialog box. If the results *Fail*, click **Restart Plane** to redigitize the white surface.



Figure 4-14 Measuring the Compensation Plate with the Ball Probe

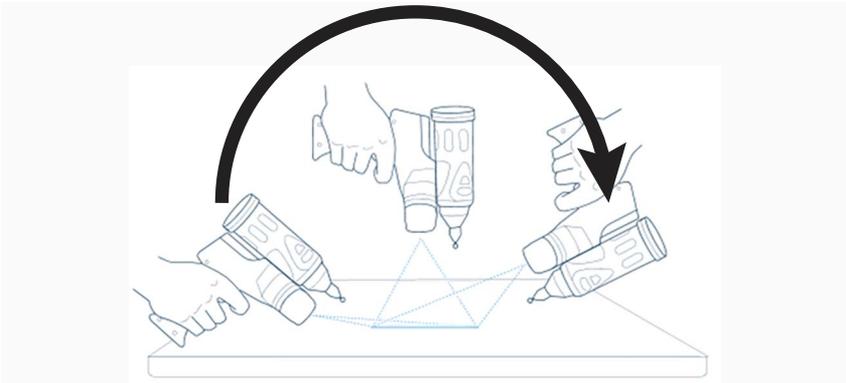
NOTE: Avoid touching the lenses. When necessary, clean the top and bottom lenses with the cloth from the FARO Laser Line Probe case. Dirt and grease on either lens can cause poor results.

2. Click **Start Compensation**. Digitize the white area of the FARO Compensation Plate with the FARO Laser Line Probe in a sweeping motion. You should collect at least 200 scan lines in the FARO Laser Line Probe compensation. If not, repeat the compensation moving the FARO Laser Line Probe slower in each step.



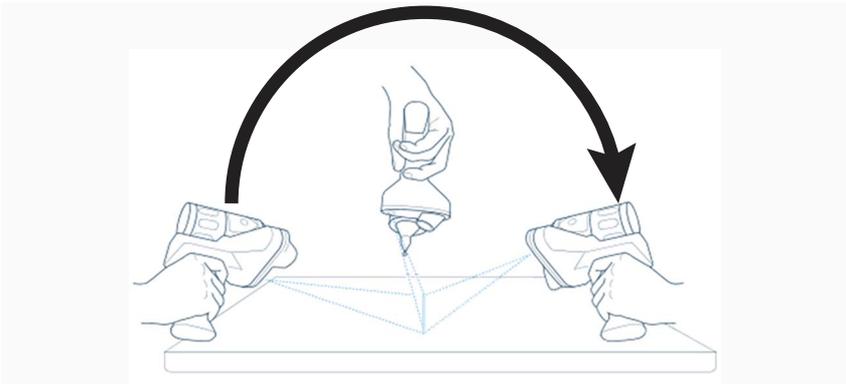
Figure 4-15 Measuring the Compensation Plate with the Laser Line Probe

- Aim the laser line at the middle of the white surface.
- Move the FARO Laser Line Probe until the laser is in the Center Range .
- Press and hold the green **Front** button and move the FARO Laser Line Probe while pointing to the center of the white surface. Rotate the FARO Laser Line Probe as much as possible - at least 90 degrees.

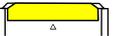


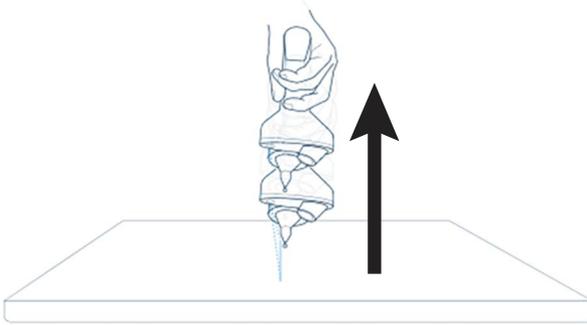
- Press the red **Back** button.

3. Digitize the white area of the FARO Compensation Plate with the FARO Laser Line Probe in a sweeping motion. You should collect at least 200 scan lines in the FARO Laser Line Probe compensation. If not, repeat the compensation moving the FARO Laser Line Probe slower in each step.
- Rotate the FARO Laser Line Probe 90°.
 - Aim the laser line at the middle of the white surface.
 - Move the FARO Laser Line Probe until the laser is in the Center Range .
 - Press and hold the green **Front** button and move the FARO Laser Line Probe while pointing to the center of the white surface. Rotate the FARO Laser Line Probe as much as possible - at least 90 degrees.



- Press the red **Back** button.

4. Digitize the White area of the FARO Compensation Plate with the FARO Laser Line Probe.
 - Aim the laser line at the middle of the white surface.
 - Move the FARO Laser Line Probe until the laser is closer than the Near Range .
 - Press and hold the green **Front** button and slowly move the FARO Laser Line Probe beyond the Far Range  while pointing to the center of the white surface.



- Press the red **Back** button.

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. Click Save and Exit to complete the compensation.

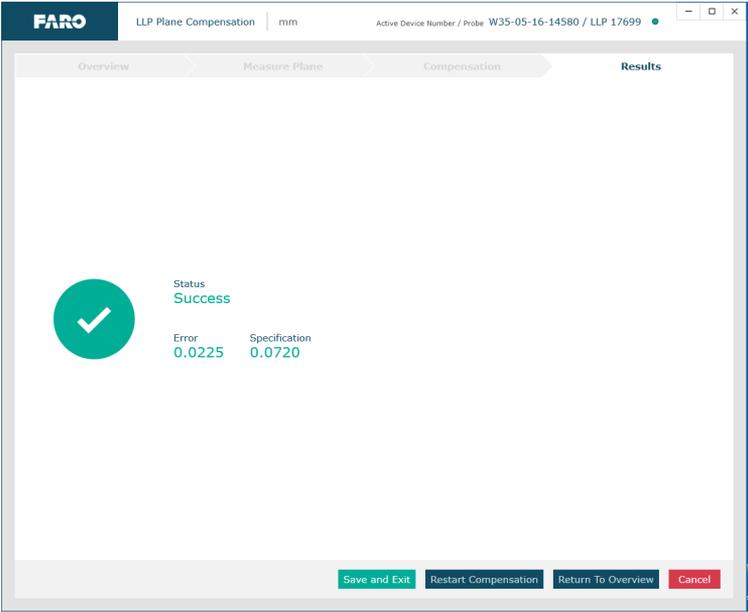


Figure 4-16 Laser Line Probe Compensation Results

You now have two probes to digitize your part. Use the **Probe Management** command to switch between the standard ball probe and the FARO Laser Line Probe.

NOTE: If you remove the FARO Laser Line Probe, you *must* re-calibrate it again to guarantee the accuracy of the measurements. *For more information, see “Probe Compensation” on page 59.*

NOTE: You can view the details for all probe compensations by clicking **View All**. *See “View Log” on page 74.*



Figure 4-17 Probe Compensation List

DRO

Some software packages add a Digital ReadOut (DRO) window to the screen. The DRO window displays the current location of the probe in the current coordinate system.

- If the FARO Laser Line Probe is in range, the X, Y, Z coordinate is the center of the laser line. Note that this may not be the center of the complete laser line because some part of the laser line may be out of range.
- If the FARO Laser Line Probe is out of range, then no coordinate is available and the DRO displays a row of asterisks (*****).

FARO Laser Line Probe Settings

Modify the settings of the FARO Laser Line Probe for your part. The default settings are for digitizing the compensation sphere or plane that has an opaque white surface. You can control the following:

- Scan Rate - the number of lines per second that the FARO Laser Line Probe records and sends to your current file. Fewer lines per second requires you to move the FARO Laser Line Probe slower.
- Scan Density - the amount of points each line contains. More points in each line creates a larger file. If you are digitizing a relatively flat surface, use less points.
- Material - controls the camera which records the laser line. Different part material colors and textures reflect the laser line differently.
- Advanced Settings - controls the exposure settings of the camera.

To change the FARO Laser Line Probe settings:



Figure 4-18 Probes dialog box

- Choose the Laser Probe probe in the PROBES dialog box.
- Click **Edit**.

In the EDIT PROBE dialog box, you will see all of the information about the FARO Laser Line Probe:

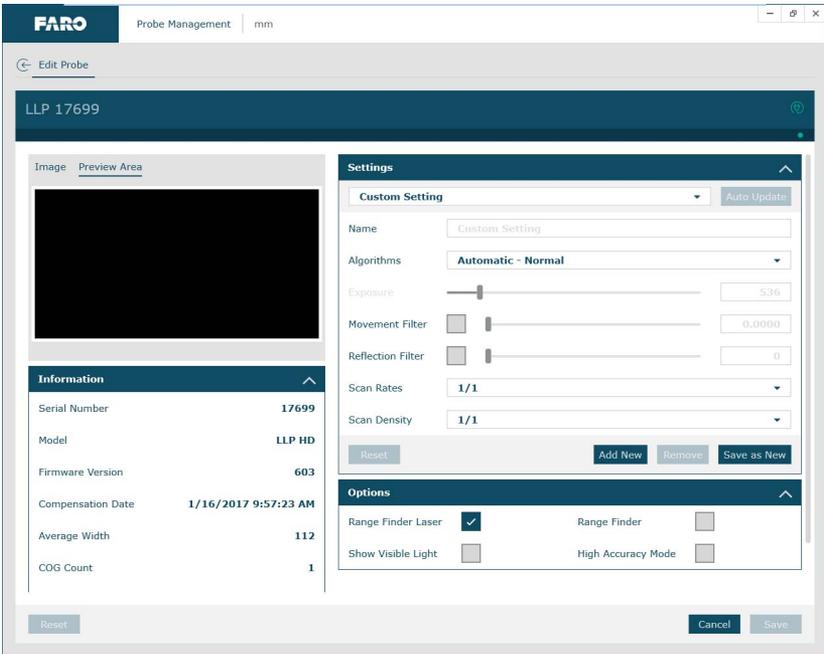


Figure 4-19 Modify Probe dialog box

When the FARO Laser Line Probe is within the operating range, you will see the line in the PREVIEW AREA of the dialog box.

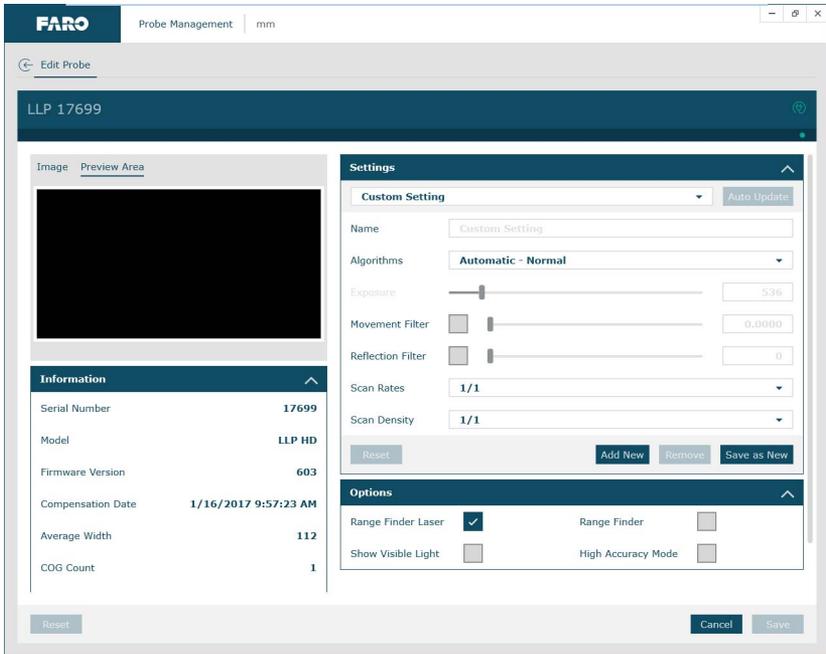


Figure 4-20 FARO Laser Line Probe Control dialog box

- Disable the Range Finder Laser box by clearing the RANGE FINDER LASER ON/OFF check box. For more information, see “Range Finder” on page 94.
- Disable the RANGE FINDER dialog box by clearing the RANGE FINDER WINDOW ON/OFF check box. For more information, see “Range Finder Dialog Box” on page 96.
- Select the SHOW VISIBLE LIGHT check box to add all visible light to the Preview window.

NOTE: Adding all visible light to the preview window will decrease the number of frames per second sent to the computer and should only be used when diagnosing problems with the FARO Laser Line Probe.

- Select the HIGH ACCURACY MODE check box to operate the FARO Laser Line Probe in the High Accuracy mode. High Accuracy mode improves the resolution of the FARO Laser Line Probe. However, it reduces your field of view by one half and shortens your effective maximum scan line width to

two thirds of the normal width, optimizing the resolution of the FARO Laser Line Probe

NOTE: Always clear this check box when compensating the FARO Laser Line Probe. See “*FARO Laser Line Probe Compensation*” on page 97.

Scan Rate and Density

Use the Scan Rate Density settings for data reduction. Reducing the number of points the FARO Laser Line Probe collects can improve system performance, increase scanning speed and potentially reduce unwanted noisy data.

- Scan Rate - choose the number of scan lines per second. 1/1 is the normal rate of scan lines per second, set this to discard scan lines.

NOTE: Always set the scan rate to 1/1 when calibrating the FARO Laser Line Probe.

- Scan Density - choose the number of points on each scan line. 1/1 is all of the points on the laser line, set this to discard points on each line.

Information

- The INFORMATION section displays the unique information for the current FARO Laser Line Probe.

Basic Settings

- From the MATERIAL drop-down window choose any existing material setting. Use the commands in this drop-down window to save material settings.

NOTE: The current material setting is stored on your computer and in the Quantum. If you connect the Quantum to another computer, the current material will be *Unknown*. Save the material settings to copy the settings from the Quantum to the new computer.

- Click the **Auto** button to set the Noise Threshold, Exposure, and Laser Intensity levels for the current material. Hold the FARO Laser Line Probe in position, pointing at the surface, until the process completes. You can also set the values manually:
 - Exposure - How long the “shutter” is open and the sensor is exposed to light in the camera. Move the slider, or enter a number; the corresponding value in milliseconds appears next to it. Light colors and reflective surfaces are better captured with low exposure levels. Darker colors typically require higher exposure levels.

- Movement Filter - A filter to prevent the capture same line of data. The value is the distance the line must move before capturing another line of data.

NOTE: The *Automatic* algorithms disable the **Auto** button and the EXPOSURE and LASER INTENSITY sliders.

Advanced Settings

- Algorithms - Select an exposure setting:
 - **Fixed Exposure:** The Exposure setting is constant and does not automatically adjust during use.
 - **Automatic - Normal:** This is an automatic mode to scan non-reflective, or dull, materials. The EXPOSURE level is set to a low level and as you digitize, the LASER INTENSITY setting automatically adjusts to maintain the proper saturation level.

NOTE: FARO recommends this algorithm for the compensation of the FARO Laser Line Probe HD. *For more information, see “FARO Laser Line Probe Compensation” on page 97.*

- **Automatic - High Contrast (HDR):** This is an automatic mode to scan high-contrast surfaces such as a black and a white surface. This algorithm uses a dual exposure where the first exposure is looking for high return surfaces such as white and the second exposure is looking for low return surfaces such as black.

NOTE: Using this algorithm reduces the rate of data capture in half.

NOTE: The *Automatic* exposure algorithms disable the **Auto** button and the EXPOSURE and LASER INTENSITY sliders.

Choosing any of the Automatic settings adds an exposure indicator to the RANGE FINDER dialog box. In the RANGE FINDER dialog box:

- A green dot in the upper left-hand corner of the RANGE FINDER dialog box indicates that the exposure has been adjusted and you are ready to scan.
- The indicator changes to either a red “+” (plus) or “-” (minus) sign indicating that the FARO Laser Line Probe is either over-exposed or under-exposed, and it is automatically adjusting the exposure. The FARO Laser Line Probe does not collect data during this adjustment, however this automatic adjustment process is very fast.

For more information, see “Range Finder Dialog Box” on page 96.

- Reflection Filter - This is a filter to remove unwanted points when scanning reflective surfaces. The filter is automatically included in the *Automatic - Reflective* algorithms. Control the amount of filtering by moving the slider:
 - Minimum amount - move the slider all the way to the left.
 - Maximum amount - move the slider all the way to the right.

NOTE: Points affected by the Reflection Filter will be colored blue in the Preview window.

Saving Materials

- Choose **Save As...** in the MATERIAL drop-down window to save a material setting.

In general, the default values for all settings described here will yield acceptable data on most surfaces. The EXPOSURE parameter requires more frequent adjustments based on the different surface finishes you are scanning.

Keep in mind that given the vast range of colors, textures and finishes, there is no exact science for these FARO Laser Line Probe Settings that work best on a particular surface. Finding the optimum settings may require some practice.

Additional Considerations

- First, if accuracy is not an issue, even failing probe compensation will not prevent you from using the FARO Laser Line Probe to show the concept of gathering point clouds quickly and easily, directly into software applications. The ScanArm *does* use the new probe compensation, even if it fails.
- Second, if the probe compensation does fail, you should look at the probe compensation log to see by how much. If the error is acceptable, you should be able to scan effectively for medium accuracy applications.
- Third, if you need to measure in a high accuracy application, or you have a requirement that the probe compensation pass, make sure you allow the FARO Laser Line Probe to warm-up for the amount of time recommended for your model. See *“Diagnosing FARO Laser Line Probe Accuracy Problems” on page 141.*

Renishaw TP-20 Probe Installation and Operation

The Quantum supports the Renishaw TP-20 touch-trigger probe by using the FARO i-Probe adapter to connect the TP-20 probe module to the Quantum

Handle. Simply attach this assembly just as you would any other probe. See “*Installing Probes*” on page 19.

The Renishaw TP-20 touch-trigger probe automatically digitizes a point by touching the stylus to the part.

NOTE: The Renishaw TP-2 Probe is *not* supported.

Quantum TP-20 Probe Kit

The Quantum TP-20 Probe Kit contains:

- A magnetized TP-20 probe body
- Medium Force Probe Module
- Renishaw (S1) C Spanner wrench
- Renishaw (S7) stylus tool
- Renishaw (CK200) cleaning kit
- Renishaw Probe tip: 2 mm (M2 D2R L10)
- Renishaw Probe tip: 6 mm (M2 D6R L10)
- Quantum i-Probe adapter

NOTE: The product numbers in the parentheses are Renishaw part numbers. See the *Renishaw User's Manual* for more details.

To install the TP-20 Probe:

1. Hold the end of the Quantum on the underside with one hand and open the probe locking lever with your other hand.
2. Remove the current probe.
3. Slide the Quantum i-Probe adapter onto the end of the Quantum. Rotate the probe until the marks on the probe and the handle match.
4. Close the probe locking lever.
For more information, see “Installing Probes” on page 19.
5. Screw the TP-20 probe body into the Quantum i-Probe adapter and hand-tighten with the C Spanner (S1) wrench.
6. Attach a probe module to the TP-20 probe body. On the probe body and probe module are triangle, half-moon, and square markers that must be aligned for the probe to work properly.
7. Screw the Renishaw Probe tip into the probe module with the stylus tool (S7). Do not under- or over-tighten any of the components.

Probe Modules for the TP-20 Probe

Probe modules are available from Renishaw in three trigger force ratings:

- Standard Force Probe Module (Black cap)
- Medium Force Probe Module (Gray cap)
- Extended Force Probe Module (Brown cap)

Refer to the *Renishaw TP-20 Installation and User's Manual* for the TP-20 Probe assembly instructions.

Measuring Software

The measuring software must be configured for the probe. If you are using CAM2 Measure:

1. Open the DEVICE CONTROL panel and click PROBE MANAGEMENT. See “Probes” on page 55.
2. If the TP-20 probe adapter is not automatically recognized, click **Find**. Ensure the Auxiliary port is active and the De-bounce Time is not zero (0). See “Edit Probe” on page 57.
3. Compensate the probe using the FARO Compensation Sphere, or any precision sphere, after installation. For more information, see “Sphere Compensation Method - 6-Axis” on page 67 or “Sphere Compensation Method - 7-Axis” on page 70.

NOTE: The probe compensation information stores for the adapter. However, since the probe tip is removable, do not rely on an existing compensation unless you are certain that the TP-20 body or the probe tip have not been changed.

Some software packages have other probe options that must also be controlled. See the *Renishaw User's Manual* for more information.

Operation

The probe digitizes a point when it makes contact with an object. The Handle LED changes to red and back to green after the De-bounce Time. Additional points will not record until after the de-bounce time has elapsed.

NOTE: The green and red handle buttons are active. Hold the handle in a manner so that you do not accidentally press the green or red buttons while measuring.

Custom Probe Compensation

Any probe with a sphere or a point can be compensated. See “*Probe Compensation*” on page 59.

Chapter 5: Accuracy

This chapter describes the definitions and specifications of accuracy, or performance specification, for the Quantum.

The Quantum performance testing standard is the ISO 10360-12 and ISO 10360-8. Single-point repeatability (SPAT) is measured using a hard probe in a reference hole. Volumetric (EUni) performance is measured using a hard probe and a traceable length artifact. Measurements are well distributed in all regions of the working volume. *For more information, see “Product Specifications” on page 145.*

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Compensation and Calibration

The Quantum is designed to endure the typical stress and impact loads of a “factory floor” measuring tool, as well as survive multiple transportation cycles while maintaining its accuracy throughout its usable life. In order to fully appreciate what is meant by “Lifetime Calibration,” you must first understand several basic concepts of measurement equipment.

Compensation versus Calibration

In most cases, the terms “compensation and calibration” are used together, and are often mistakenly used interchangeably. This generally occurs because traditional Coordinate Measuring Machines are often compensated every time they are calibrated. In reference to the Quantum, there are two types of compensation: the Quantum compensation and the probe compensation.

Quantum Compensation

Compensation is the procedure by which a measurement device is optimized to perform accurate measurements. This may be done through mechanical adjustments, as well as software corrections.

Specialists at FARO’s production facility perform the factory compensation. This compensation utilizes patented hardware and software (not available to the user) to determine the true dimensions and kinematics of the Quantum. The results of the factory compensation are imprinted to memory located in the Quantum

electronics. The Quantum is permanently compensated, such that it does not require mechanical adjustments during normal operation.

The Quantum compensation becomes invalid (stop functioning within FARO's published standards) if one or more of the following occurs:

- Bending of the transfer cases (long, tube sections).
- Damage to the encoder-bearing interface joints (where tubes, bearings and encoders are mated).
- Failure of the encoder-electronics system (changes motion into electrical data).
- Excessive impact with another object or an end stop. The impact may cause the transfer cases to bend, the joint housings to deform, or the encoder-bearing interface pin system to loosen.

Any of these problems require FARO's Customer Service Department to disassemble the Quantum, repair the necessary item(s), and perform a factory compensation. A factory compensation is necessary since the physical nature of the Quantum has been changed.

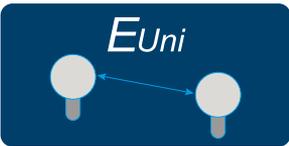
ISO 10360 Standard

Accuracy testing and certification is according to the ISO 10360-12 standard, and the ISO 10360-8 standard for the ScanArm.

ISO 10360-12 Standard

The ISO 10360-12 standard requires four probing and one distance test. The tests results are an error and each test has a Maximum Permissible Error (MPE).

	<p>SPAT - <i>Single Point Articulation Test</i>.</p> <p>The operator seats the Quantum probe in a hole and measures points while moving the joints. The error is the greatest distance between any two points.</p>
	<p>PSize - <i>Sphere Probing Size Error</i>. The operator measures a sphere with the Quantum probe. The error is the difference between the measure and actual diameter of the sphere.</p>

	<p>P_{Form} - <i>Sphere Probing Form Error</i>. The operator measures a sphere with the Quantum probe. The error is maximum distance of any point from the best-fit sphere.</p>
	<p>L_{Dia} - <i>Sphere Location Diameter Error</i>. The operator measures a sphere with the Quantum probe from multiple orientations. The error is the diameter of the spherical zone containing the centers of the measured spheres.</p>
	<p>E_{Uni} - <i>Unilateral Distance Error</i>. The operator measures two sphere, or two points, with the Quantum probe. The error is the difference between the measure and actual length between the spheres or points.</p>

ISO 10360-8 Standard

Annex D of the ISO 10360-8 standard requires one distance test. The test result is an error and has a Maximum Permissible Error (MPE).

	<p>L_{Dia} - <i>Sphere Location Diameter Error</i>. The operator measures a sphere with the Quantum probe from multiple orientations. The error is the diameter of the spherical zone containing the centers of the measured spheres.</p>
--	--

Quantum Calibration

The FaroArm Manager software has commands that allow you to perform tests that certify the accuracy and repeatability of your Quantum. The Single Point Repeatability Test (SPAT) allows you to test the Quantum using a hole. Use measuring software such as CAM2 Measure to test the volumetric accuracy.

The values measured in all of these calibrations include 100% of the measured points. We will always refer to this as the “Max. minus Min. over Two,” or the Maximum measurement subtracting from the Minimum measurement divided by two (Max.-Min.)/2.

If any test fails, print the results and repeat the calibration two more times. Print all of the results and contact FARO's Customer Service by Phone, Fax or E-Mail. See *“Technical Support” on page 161.*

Repeatability

Perform the Single Point Repeatability Test to check repeatability (SPAT) of the Quantum using a hole or a cone. You must use a firmly secured object with a hole at least 1mm smaller than the ball probe. If a cone hole is used, extreme care must be taken to ensure that the probe is seated at each “measurement.”

- Use a calibrated ball probe. See *“Installing Probes” on page 19* and *“Probe Compensation” on page 59.*
- Run the Single Point Articulation Test (SPAT). See *“Single Point Articulation Test (SPAT)” on page 138.*

Volumetric Accuracy

Perform a Sphere to Sphere, or Point to Point length measurement in order to certify the volumetric accuracy (EUni) of the Quantum. This should be done using traceable length artifacts, which are measured at various locations and orientations throughout the working volume of the Quantum. This test is a method for determining articulating measurement machine accuracy.

- Use a calibrated ball probe. See *“Installing Probes” on page 19* and *“Probe Compensation” on page 59.*
 1. Measure points on each feature, from multiple directions. Ensure that you digitize points on the entire Sphere surface.
 2. Make sure that you move the joints of the Quantum while measuring the points.
 3. Do not digitize a point if any of the encoders reach their end stop. See *“Error and Status Indicators” on page 37.*
 4. Avoid a joint position where a degree of freedom is lost in the Quantum. See *“Loss of a Degree of Freedom” on page 117.*

The specifications (SPAT and EUni) of your Quantum are listed on the label between the battery pack slots.

Serial Number:		Rev.:
W25-05-16-14498		1
Part Number:	Model:	Cert. Date:
21000-725	21000	Aug 02, 2017
Single Point:	Volumetric:	Mfg. Date:
0.024 mm	0.034 mm	Aug 02, 2017
MADE IN USA		Company #97854 complies with UL/CSA 61010-1
Patents: See www.faro.com/patents		



Figure 5-1 Quantum Accuracy Label

NOTE: For optimum performance, correctly mounting and operating the Quantum is very important. *For more information, see “Quantum Performance Verification Checklist” on page 132.*

Loss of a Degree of Freedom

In a working volume of the Quantum there can be a loss of a degree of freedom (natural rotation of each joint). With this loss, temporary bending occurs on the transfer tubes of the Quantum causing a movement of the probe position that cannot be recorded by the Quantum’s encoder system. Measurement results taken in these positions are not accurate. This condition is never encountered in the compensation of the Quantum. Common areas of measurement where this loss occurs are:

- when an encoder has reached a hard end stop,
- directly above the Quantum, or
- in close to the base of the Quantum.

The Quantum should always feel fluid in its movement. If excessive force is needed to move to a measuring location, a degree of freedom has probably been lost. The following figures illustrate some of the possible positions of the Quantum where a degree of freedom has been lost.

Chapter 6: Maintenance and Troubleshooting

This chapter describes the basic maintenance for your Quantum and some examples of common problems and their solutions.

CAUTION: There are no user serviceable parts in this device. *DO NOT* attempt to open the casing or disassemble the device at any time.

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Normal Maintenance

Quantum

The Quantum 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 Quantum when not in use.
- Clean with a dry dust cloth. For heavy dirt buildup, use a *very* small amount of warm water and gently clean the Quantum. Be very careful not to bend the Quantum while cleaning.
- Check the cables for damage to outside insulation, connectors, and pins.
- *DO NOT* lubricate the Quantum.

The Quantum is compensated at FARO's production facility and should only need to be recompensated after the unit has been subjected to a shock that removes surface material or causes bending. Periodic calibration tests should be completed to certify the Quantum accuracy and repeatability. See *"Quantum Calibration"* on page 115.

FARO recommends you return your Quantum to a service center, once a year, for our annual calibration 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 contact your Customer Service Representative by Phone, Fax or E-Mail. See *"Technical Support"* on page 161.

Mounting Stiffness Test

The Quantum is portable and can be mounted in a variety of environments. The Quantum 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 Quantum if the deformations are sufficiently large.

The primary forces encountered due to counterbalancing are translation and torsion. These forces are illustrated in Figure 6-1, Figure 6-2, and Figure 6-3. 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 calibration.

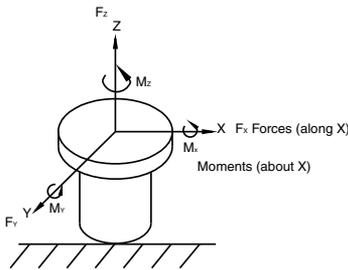


Figure 6-1 Forces Encountered due to Counterbalancing

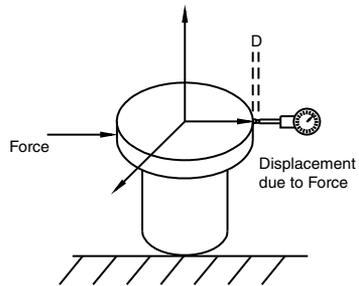


Figure 6-3 Displacement due to Force

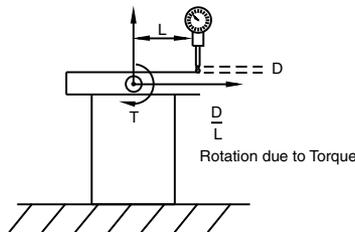


Figure 6-2 Rotation due to Torque

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 Quantum 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 Quantum 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:

1. Turn off the Quantum.
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 161. Have the message ready.

Probe compensation fails.

- Make sure the Quantum probe is secure.
- Make sure that the compensation hole, cone or sphere is located about $\frac{2}{3}$ the distance of the Quantum from the base.
- Make sure that the compensation 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.
- Compensate the probe again, and check that all points were digitized properly.
- Use the other compensation method (sphere or hole).

Buttons (green **Front** & red **Back**) will not respond.

- Make sure that all of the encoders are referenced. See “*Referencing the Encoders*” on page 38.
- Turn auxiliary port OFF. See “*Edit Probe*” on page 57.
- Check buttons in Diagnostic command. See “*Diagnostics*” on page 80.

Single-point calibration shows excessive error.

- You must use a ball probe. Check that it is installed correctly. See “*Installing Probes*” on page 19.
- Re-compensate probe. See “*Probe Compensation*” on page 59.
- During the test, watch the probe to ensure flush seating in the hole. See “*Quantum Calibration*” on page 115.

Power Issues

If the Quantum 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 “Quantum Power Supply” on page 32.*
- Check the power supply for physical impacts or damage. **DO NOT** use a damaged power supply.
- Check functionality of the Quantum. 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 Quantum and the host computer.

PLEASE READ BEFORE BEGINNING THE PROCESS

If communication between the computer and the Quantum is lost, or if it could not be established:

- Ensure you are using the correct cables.
NOTE: *DO NOT* use a USB to Serial/Parallel adapter to connect the Quantum.
- 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; smart phones, tablets, digital cameras, scanners, modems and external devices are known to cause these conflicts.
- Check that only the FaroArm Manager is running on the computer. Ensure multiple sessions of the measuring software are not running.
- Check functionality of the Quantum. Look for error codes or operation issues.
- Check functionality of power supply. Look for error codes or damage to the housing.
- Check functionality of your 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

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

Bluetooth

- You have set up your connection using your platform specific Bluetooth Wizard and the FARO Bluetooth Connection Setup utility, but software application does not find the Quantum.
 1. Ensure sure the Quantum is receiving power and the On/Off button is set to the *ON* position. When the On/Off button is set to the *ON* position, it lights blue.
 2. Ensure the Bluetooth transmitter is set to the *ON* position. When the Bluetooth button is set to the *ON* position, it lights blue.
 3. Ensure your computers wireless radio is on. Some computers have a hard switch for the wireless receiver and some are only controlled through a software switch.
 4. 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.
 5. Click **Start > Devices and Printers** and make sure the Quantum is still in the list. If not, refresh the list.

If the Quantum is switched on and the PC's Bluetooth hardware is connected correctly, and the connection is still unavailable contact FARO's Customer Service.
 6. Right-click the Quantum device and choose **Properties**. Click the **HARDWARE** tab, and look to see what COM port is assigned to your Quantum.
 7. Click **Start > FARO > FARO Bluetooth Connection Setup** 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 Quantum 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 FaroArm driver software is current. The latest driver software may be on a separate USB flash drive that came with your Bluetooth equipped Quantum, or any other FARO software package. If you are unsure about what version of the FaroArm driver you are running contact your Customer Service Representative by Phone, Fax or E-Mail. See "*Technical Support*" on page 161.
- 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 Quantum.

WLAN

1. Ensure sure the Quantum is receiving power and the On/Off button is set to the *ON* position. When the On/Off button is set to the *ON* position, it lights blue.
2. Ensure the WLAN transmitter is set to the *ON* position. When the WLAN button is set to the *ON* position, it lights blue.
3. Ensure your computers wireless radio is on. Some computers have a hard switch for the wireless receiver and some are only controlled through a software switch.
4. Ensure the computer operating system wireless card utilities are running correctly and have not disables the receiver.

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 FaroArm driver?

Two.

- Can both USB and Bluetooth wireless Quantums be connected simultaneously?

Yes.

- Can a single Quantum 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 Quantum.

- Can I use a FARO Laser Line Probe with the FARO Wireless connection?

Yes.

- Can I add a Bluetooth wireless connection while the FaroArm driver is already running?

No, the FaroArm 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 FaroArm 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 Quantum 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 Quantum while it is connected using the FARO Wireless connection?

Once the FaroArm driver detects that the Quantum 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 Quantum 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.

- Can I use all of the communication options at the same time?

You can use multiple communication protocols with the following limitations:

- USB, Ethernet, and Bluetooth are active at the same time, WLAN is disabled
- USB and WLAN are active at the same time, Bluetooth is disabled.
- WLAN is disabled if Ethernet is active
- WLAN is disabled if Bluetooth is active

WLAN Primer

A FaroArm node or station can connect to a WLAN that complies with the IEEE 802.11n standard. The Wi-Fi Alliance (an industry group promoting 802.11 networks) has popularized the term Wi-Fi® for 802.11 compliant networks. The term WLAN, refers to the slightly more generalized concept of the wireless extension of a local area network (LAN), though in practice most implementations use Wi-Fi technology.

The IEEE 802.11 standard specifies a Medium Access Control (MAC) and physical layers (PHY) for wireless connectivity between stations (STAs). A set of stations that have joined the same network have access to the same network services. These services are called a Basic Service Set (BSS). Every BSS has a unique 48-bit identifier called the Basic Service Set Identifier (BSSID). The standard specifies two types of BSS; an Independent BSS (IBSS), and an Infrastructure BSS (BSS).

There are several different PHY layers specified in IEEE 802.11. The Quantum uses 802.11g.

IEEE 802.11 further breaks up the 2.4 GHz frequency band into 14 overlapping channels. Each country in the world has its own rules and regulations regarding radio usage. Many countries join together to coordinate these regulations, forming “Regulatory Domains”. Most European, Middle Eastern, North and South American, and African countries, and Australia and Japan use the same regulations. However, there are differences with regard to which channels and power levels are permitted. The Quantum can support all 14 channels - factory programming is performed for the specific country where the Quantum is to be used (this is not a user option).

Independent BSS (IBSS)

An IBSS is used to form an Ad Hoc network between peer STAs. STAs share responsibility for maintaining the IBSS and distributing data to each other. IBSS is *NOT* supported for the Quantum WLAN.

Infrastructure BSS (BSS)

In an Infrastructure BSS there is one special STA called the Access Point (AP). The AP is solely responsible for starting and maintaining the BSS and admitting (or excluding) other STAs. The AP receives all traffic either bound for or originating from every STA that it admits into its BSS. (Exception is contained in IEEE 802.11e amendment for Quality of Service - a special QoS BSS).

The STAs are known as Clients, the AP is known as a Server.

A Distribution System (DS) interconnects a set of APs to create an Extended Service Set (ESS). The ESS is a super set of all member STAs. The DS distributes data between ESS STAs. An ESS may include LANs (via a gateway).

The simplest and most common configuration is to have an ESS that includes exactly one AP. It is known as a Small Or Home Office (SOHO). This is the intended configuration for the Quantum Stations.

In an Infrastructure BSS, the AP broadcasts Beacon frames that announce the identity and capabilities of its BSS.

Joining a WLAN

An STA joins a WLAN using a three-step process:

1. Scanning
2. Association
3. Authentication

Scanning

The STA generates a list of all BSSs (APs in the network) it can detect.

Association

In an Infrastructure BSS the Association process requires a frame exchange between the joining STA and the selected AP. This frame includes the STA's capabilities. The AP will accept or deny the request (Association Response Frame). The STA (Client) learns the BSSID (SSID - Service Set Identifier or WLAN name) and AP MAC address. If the STA is accepted the AP will issue an Association Identifier (AID - logical port) at this time.

Authentication

Apply Security - establish a secure wireless network. WPA2-Personal is recommended for the FARO WLAN security (based on IEEE 802.11i and Advanced Encryption Standard -AES). The password is the real key to security!

Establishing a FARO WLAN Connection

There are a minimum of three STAs to be configured. This may be performed in any order but the typical order is:

1. Set up an Access Point
2. Set up the Quantum
3. Set up the Host Computer

Access Point (AP)

Normally the Access Point is configured first. This setup may have been done by your IT department. If this is the case, IT should provide the Network Name (SSID) and Password.

All Clients must use the same SSID and Password as the AP.

The recommended security setting is either WPA-PSK (TKIP encryption algorithm) {Good} or WPA2-PSK (AES-CCMP encryption algorithm) {Better, if available}. You should use a Password of 10 or more random alphanumeric characters.

NOTE: Wi-Fi Protected Access (WPA).

The Host Computer Setup

The AP should be configured and running.

The ease of configuring client stations depends principally on the configuration utility used. Windows XP comes with its own configuration utility built in, Windows Zero Configuration Utility (WZC). However, there are other configuration utilities that offer better efficiency, easier configuration, and better wireless monitoring. Most Client cards come with their own wireless configuration utility, though others depend on Windows. Here we will describe the configuration of Client stations using WZC, which is the lowest common denominator for most users.

1. Add preferred network - Enter SSID (example here is “My Network SSID”).
2. Configure Client to the same settings as the AP. To do so, click on the **Properties** button. The SECURITY PROPERTIES dialog box appears. The first text box will already be filled in with the SSID selected for the preferred network name.
3. In the NETWORK AUTHENTICATION drop-down window, select WPA-PSK.
4. In the DATA ENCRYPTION drop-down window, select TKIP.

5. The last step is most important - the Network Key entered and confirmed must be the same as the network key (password) that was entered on the AP.

NOTE: Network keys are case sensitive.

FARO i-Probe FAQ

- Can I use a Quantum i-Probe on anything other than the Quantum?
No. Installing the Quantum i-Probe to anything other than a FaroArm Quantum damages the i-Probe.
- Can I still use my old probes on the Quantum?
Yes when using the correct probe adapter.
- How many i-Probes can the Quantum remember?

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Quantum Performance Verification Checklist

If you are experiencing accuracy or repeatability problems with your Quantum or FARO 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 Quantum and ScanArm.

Issues That Will Degrade Accuracy

Mounting

- 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.
- Folding tripods without using the stabilizing struts are unstable.
- Heavy-duty stands with wheels down and pins up are unstable.
- Part deformation due to excessive clamping force.

Compensation

- Deflection of compensation artifact.

FARO Laser Line Probe:

- Damage to compensation artifact.

- *DO NOT* drag the probe over the FARO Compensation Plate during the plane measurement. Lift the probe in between points to avoid scratching the surface of the plate.
- Poor probe compensation technique.
 - *DO NOT* do short sweeps with the FARO Laser Line Probe during compensation.
- 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

- Measuring with Point Probes.
- Measuring with chipped, loose or cracked ball probes.
- Measuring with probe extensions. The extensions will deflect.

Measurement Environment

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

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

Quantum Setup

- ❑ 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 > Hardware Configuration** command and click **Temperature**.

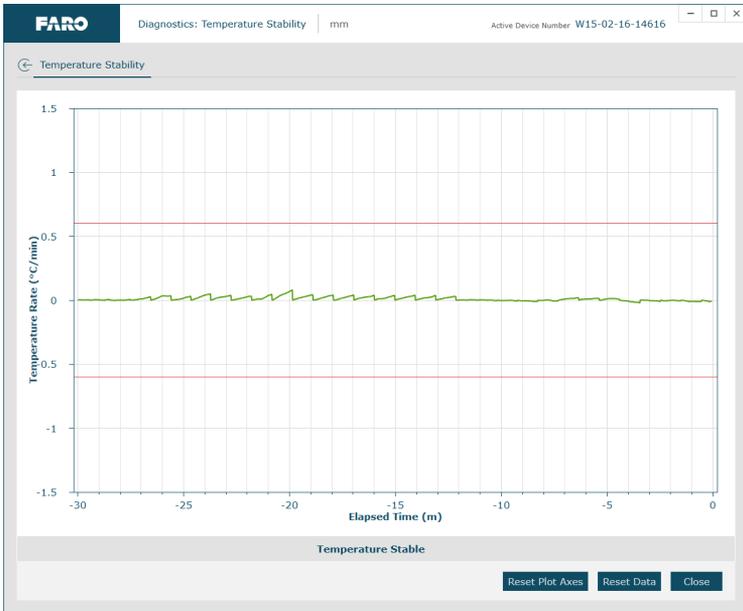


Figure 6-4 Temperature Stability dialog box

- For more information, see “Temperature Stability” on page 84.

Probe Setup



Figure 6-5 Installing a Probe

- ❑ Check probe seating.
- ❑ Install by hand.
- ❑ Verify that the probe has no chips or cracks, is not loose, and that it has no flat spots.

Probe Compensation

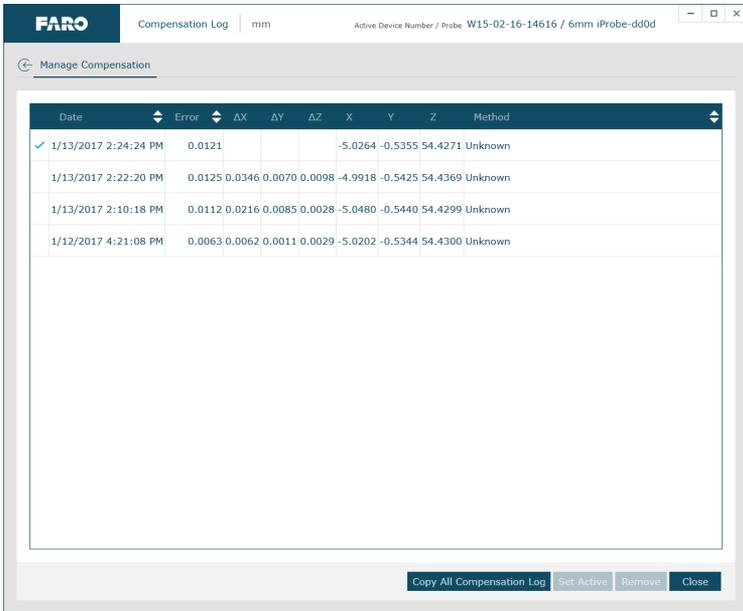
- ❑ Place the compensation cone approximately $\frac{2}{3}$ of the Quantum's reach away from its base.



Figure 6-6 Probe Compensation

- ❑ Perform the probe compensation at least 3 times. *For more information, see “Hole Compensation Method” on page 63.*

- ❑ Look in the probe compensation log and compare the X, Y and Z values. Each value should repeat to within the accuracy of the device.



The screenshot shows the 'Compensation Log' window for a 6mm iProbe-dd0d. The window title is 'FARO Compensation Log | mm Active Device Number / Probe: W15-02-16-14616 / 6mm iProbe-dd0d'. The main content area is titled 'Manage Compensation' and contains a table with the following data:

Date	Error	ΔX	ΔY	ΔZ	X	Y	Z	Method
✓ 1/13/2017 2:24:24 PM	0.0121				-5.0264	-0.5355	54.4271	Unknown
1/13/2017 2:22:20 PM	0.0125	0.0346	0.0070	0.0098	-4.9918	-0.5425	54.4369	Unknown
1/13/2017 2:10:18 PM	0.0112	0.0216	0.0085	0.0028	-5.0480	-0.5440	54.4299	Unknown
1/12/2017 4:21:08 PM	0.0063	0.0062	0.0011	0.0029	-5.0202	-0.5344	54.4300	Unknown

At the bottom of the window, there are buttons for 'Copy All Compensation Log', 'Set Active', 'Remove', and 'Close'.

Figure 6-7 Probe Compensation Log

NOTE: If one person is able to repeat better than another person, review probe compensation procedure. A “green light” does not guarantee a good probe compensation. It simply indicates that the data collected was within specification.



Mounting

Most accuracy and repeatability problems can be attributed to improper mounting of the Quantum. 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 magnetic mount to rock back and forth. The magnet will naturally attract these shavings.
- ❑ If using a vacuum mount, check that mating surfaces are clean and free of debris. Ensure you are using the proper amount of vacuum oil.

Base Deflection

1. Start the FaroArm Manager software and connect your Quantum.
2. Click **Diagnostics > Base Deflection**.
3. Set up the FARO compensation cone, or a hole on your part, approximately $\frac{2}{3}$ of the Quantum's reach away from its base.
4. Place a properly compensated probe firmly in the cone. The probe must be well-seated in the hole.
5. Press the green Front button and move the tubes and joints of the Quantum while keeping the probe firmly seated in the cone.
 - Press the green **Front** button to reset the screen at any time.
6. Press the red **Back** button to stop.
7. Any deflection of the base is recorded and displayed on the screen. All of the points must be within the circle on the graph.

Tilt

1. Click **Diagnostics > Diagnostic Tilt**.
2. Hold the handle in the air approximately $\frac{2}{3}$ of the Quantum's reach away from its base.
3. Press the green **Front** button and move the tubes and joints of the Quantum.
 - Any tilt of the base is recorded and displayed on the screen. All of the points must be within the circle on the graph.
 - Press **Reset** to clear the screen.

NOTE: If the Base Deflection test fails and the Tilt test passes, check the stability of your part.

Single Point Articulation Test (SPAT)

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

- ❑ Set up the FARO compensation cone, or a hole on your part, approximately $\frac{2}{3}$ of the Quantum's reach away from its base.
- ❑ In CAM2 software, start the SPAT routine from the DIAGNOSTICS dialog box.
 - In the FaroArm Manager, click PROBE MANAGEMENT.
 - In CAM2 Measure, click **Devices > Hardware Configuration**, and in the FARO DEVICE CONTROL PANEL click PROBE MANAGEMENT.
- ❑ In the PROBE MANAGEMENT dialog box, click SINGLE POINT ARTICULATION TEST (SPAT).
 - *For more information, see “Probes” on page 55.*
- ❑ Place and hold the calibrated probe in the compensation cone or any conical socket.
- ❑ Start with the elbow of the Quantum to one side and press the green **Front** button.
- ❑ Watch the screen and slowly sweep the elbow so that it ends up on the opposite side.

NOTE: Measurements automatically record as the elbow moves.



Figure 6-8 Single Point Articulating Test (SPAT)

- In the dialog box, watch the status bar. Sweep the elbow all the way to the opposite 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 Quantum movement should feel fluid. Be careful not to stress the Quantum 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 Error, or Single Point repeatability value, of each coordinate should be lower than the value printed on the Quantum.

Serial Number:		Rev.
W25-05-16-14498		1
Part Number:	Model:	Cert. Date:
21000-725	21000	Aug 02, 2017
Single Point:	Volumetric:	Mfg. Date:
0.024 mm	0.034 mm	Aug 02, 2017
MADE IN USA		TUV SUD C US
Patents: See www.faro.com/patents		
		Company #97854 complies with UL/CSA 61010-1

Figure 6-9 Quantum Accuracy Label

- ❑ Click:
 - **Report** to generate a detailed report of the test.
 - **Restart** or discard the results and repeat the test.
 - **Close** button to end the test.

User Compensation

If the SPAT results are higher than the SINGLE POINT value printed on your arm, you can run the **Arm Compensation** command in the PROBE MANAGEMENT dialog box.

- Click **Arm Compensation**.
- Start with the elbow of the Quantum to one side and press the green **Front** button.
- Watch the screen and slowly sweep the elbow so that it ends up on the opposite side.
- Slowly sweep the elbow back to the first side.

- Look at the before and after results. Click the **Yes** button to generate and save a detailed report of the test to a comma-separated values text file (*.csv file), or the **No** button to save the new arm compensation.

The new arm compensation will remain in your Quantum until changed or reset. Click the **Reset** button to restore the FARO Factory compensation.

Repeat SPAT

Repeat the SPAT with the compensation cone or conical socket in a different location. This will verify the new arm compensation.

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).

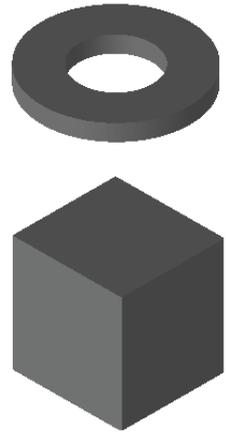
NOTE: The dimension of calibrated artifacts is usually specified at a temperature of 20°C (68°F). If the current temperature is different, use the Material Temperature Compensation function in CAM2, or the following formula:

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

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 compensation 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 correct Quantum issues prior to diagnosing the FARO Laser Line Probe. If the Quantum is not mounted correctly, or the hard probe is not accurately compensated, then the FARO Laser Line Probe will produce inaccurate results.

- ❑ 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 Compensation Plate within approximately $\frac{2}{3}$ of the Quantum's reach.

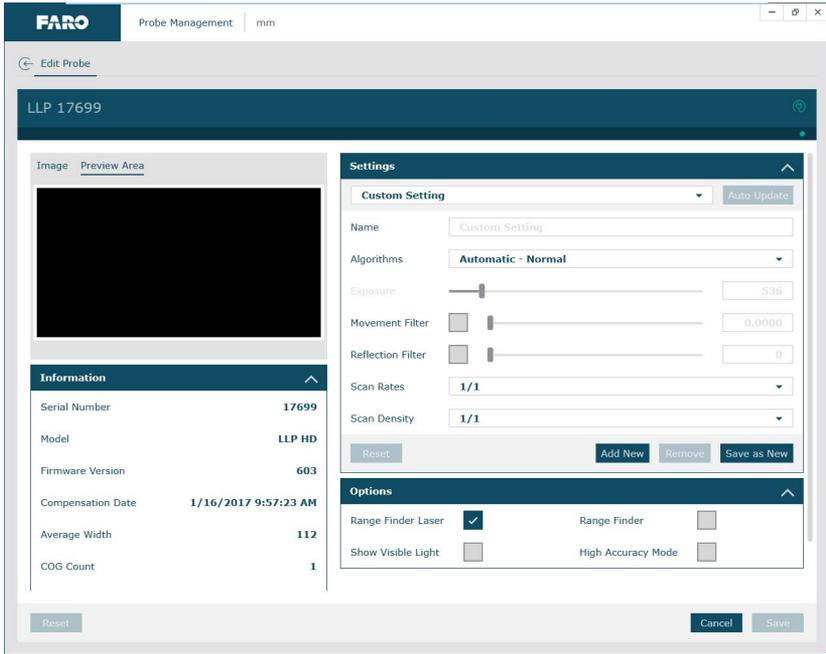


Figure 6-10 Laser Line Probe Compensation

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 Compensation

- ❑ Ensure the Scan Rate and Scan Density are set 1/1. In the Probe Management dialog box, edit the current Laser Line Probe. to access the FARO LASER LINE PROBE CONTROL dialog box.



- ❑ Perform the compensation at least 3 times. See “FARO Laser Line Probe Compensation” on page 97.

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 compensation process.

- ❑ In the probe compensation log, check the X, Y, Z values. Each value should repeat to within:
X: 100 μm (0.0039 in)
Y: 50 μm (0.0019 in)
Z: 50 μm (0.0019 in)

Date	Error	ΔX	ΔY	ΔZ	X	Y	Z	ΔA	ΔB	ΔC	Method
✓ 1/20/2017 3:20:07 PM	0.0308				41.6489	33.3935	-80.0067				LLP Plane Compens:
1/20/2017 3:21:20 PM	0.0439	2.9244	0.2346	0.1487	44.5733	33.1589	-80.1554	922.5796	0.3323	922.3671	LLP Plane Compens:
1/20/2017 3:21:49 PM	0.0446	1.8883	0.8422	0.1043	43.5372	34.2357	-80.1110	1006.9636	0.2026	1006.8727	LLP Plane Compens:
1/20/2017 3:22:34 PM	0.0580	2.3555	1.3231	0.2023	44.0044	34.7166	-80.2090	995.3965	0.2525	995.4148	LLP Plane Compens:

If additional support is required, contact your Customer Service Representative by Phone, Fax or E-Mail. See *“Technical Support”* on page 161.

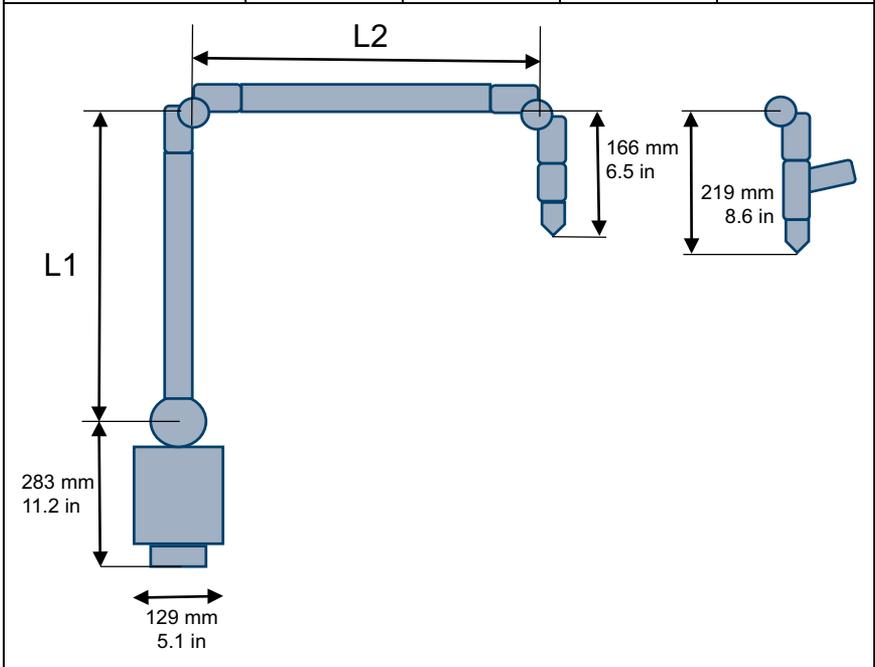
When contacting FARO’s Customer Service, please provide the following information:

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

Chapter 7: Product Specifications

This chapter contains the Quantum technical specifications and rated conditions for operation. For other FARO FaroArm models, please consult the original User Manual that shipped with your FARO FaroArm or contact FARO Customer Service by Phone, Fax or E-Mail. See “*Technical Support*” on page 161.

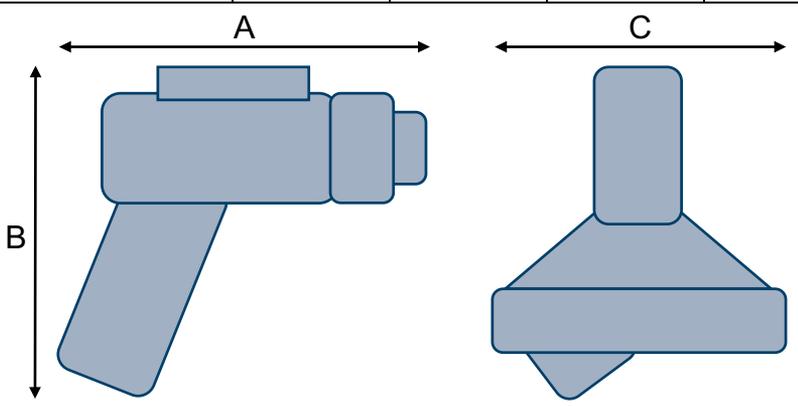
Size	L1	L2	Weight 6-Axis	Weight 7-Axis
Quantum 1.5M length	398 mm 15.7 in	213 mm 8.4 in	8.2 kg 18.0 lb	N/A
2.5M length	629 mm 24.8 in	444 mm 17.5 in	8.9 kg 19.5 lb	9.0 kg 19.8 lb
3.5M length	879 mm 34.6 in	694 mm 27.3 in	9.0 kg 19.8 lb	9.1 kg 20.1 lb
4.0M length	1004 mm 39.5 in	819 mm 32.2 in	9.1 kg 20.1 lb	9.3 kg 20.4 lb



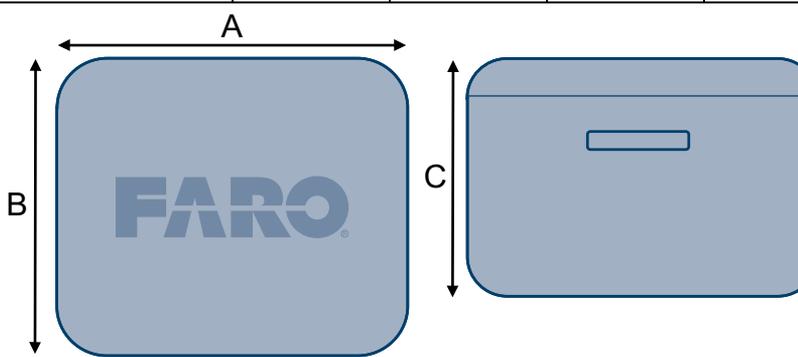
Size 6-Axis	A	B	C	Shipping Weight
Quantum Shipping Case				
1.5 M length	114.5 cm 45.1 in	40.9 cm 16.1 in	33 cm 13.0 in	26.0 kg 57.3 lb
2.5 M length	114.5 cm 45.1 in	40.9 cm 16.1 in	33 cm 13.0 in	27.1 kg 59.6 lb
3.5 M length	149 cm 58.7 in	47.2 cm 18.6 in	26.9 cm 10.6 in	30.2 kg 66.5 lb
4.0 M length	149 cm 58.7 in	47.2 cm 18.6 in	26.9 cm 10.6 in	30.5 kg 67.2 lb

Size 7-Axis	A	B	C	Shipping Weight
Quantum Shipping Case				
2.5 M length	114.5 cm 45.1 in	40.9 cm 16.1 in	33 cm 13.0 in	27.2 kg 59.9 lb
3.5 M length	114.5 cm 45.1 in	40.9 cm 16.1 in	33 cm 13.0 in	30.3 kg 66.8 lb
4.0 M length	149 cm 58.7 in	47.2 cm 18.6 in	26.9 cm 10.6 in	30.6 kg 67.5 lb

Size	A	B	C	Weight
FARO Laser Line Probe HD	190 mm 7.5 in	177 mm 7.0 in	133 mm 5.2 in	0.5 kg 1.1 lb



Size	A	B	C	Shipping Weight
FARO Laser Line Probe HD Shipping Case	29.7 cm 11.7 in	23.1 cm 9.1 in	16.5 cm 6.5 in	1.9 kg 4.1 lb



Quantum Rated Conditions	
Operating Temperature Range	10°C to 40°C 50°F to 104°F
Storage Temperature Range	-20°C to 70°C -4°F to 122°F
Temperature Rate	3°C/5 min 5.4°F/5 min
Operating Humidity	Minimum 0% RH, Maximum 95% RH
Storage Humidity	Minimum 0% RH, Maximum 100% RH
Barometric Pressure Range	Minimum 225.50mmHG, 8.878 inHG Maximum 825.07mmHG, 32.483 inHG
Power Supply	Universal worldwide voltage 100-240VAC, 47 to 63Hz

Laser Line Probe Specifications and Accuracy	
Accuracy	±25 μm (±.001 in)
Repeatability	25 μm, 2σ (.001 in)
Stand-off	115mm (4.5 in)
Depth of Field	115mm (4.5 in)
Effective Scan width	Near Field 80mm (3.1 in) Far Field 150mm (5.9 in)
Points per Line	2,000
Minimum Point Spacing	40 μm (.0015 in)
Scan Rate	280 frames/second 280 fps x 2,000 points/line = 560,000 points/sec
Laser	Class 2M

Quantum ^S Accuracy 6-Axis	ISO 10360-12 Maximum Permissible Error (MPE)
1.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.023 mm (0.0009 in) 0.012 mm (0.0005 in) 0.008 mm (0.0003 in) 0.015 mm (0.0006 in) 0.027 mm (0.0011 in)
2.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.028 mm (0.0011 in) 0.018 mm (0.0007 in) 0.010 mm (0.0004 in) 0.020 mm (0.0008 in) 0.035 mm (0.0014 in)
3.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.056 mm (0.0022 in) 0.036 mm (0.0014 in) 0.020 mm (0.0003 in) 0.040 mm (0.0006 in) 0.070 mm (0.0011 in)
4.0M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.068 mm (0.0027 in) 0.045 mm (0.0018 in) 0.024 mm (0.0009 in) 0.045 mm (0.0018 in) 0.086 mm (0.0034 in)

Quantum ^S Accuracy 7-Axis	ISO 10360-12 Maximum Permissible Error (MPE)
2.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.032 mm (0.0013 in) 0.022 mm (0.0009 in) 0.012 mm (0.0005 in) 0.025 mm (0.0010 in) 0.048 mm (0.0019 in)
3.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.070 mm (0.0028 in) 0.045 mm (0.0018 in) 0.024 mm (0.0010 in) 0.045 mm (0.0018 in) 0.100 mm (0.0039 in)
4.0M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.085 mm (0.0033 in) 0.055 mm (0.0022 in) 0.030 mm (0.0012 in) 0.050 mm (0.0019 in) 0.120 mm (0.0047 in)
Quantum ^S 7-Axis and Laser Line Probe Accuracy (ScanArm)	Maximum Permissible Error (MPE)
2.5M length Volumetric Accuracy (EUni)	0.048mm (0.0019in)
3.5M length Volumetric Accuracy (EUni)	0.080mm (0.0031 in)
4.0M length Volumetric Accuracy (EUni)	0.092mm (0.0036in)

Quantum ^M Accuracy 6-Axis	ISO 10360-12 Maximum Permissible Error (MPE)
1.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.028 mm (0.0011 in) 0.018 mm (0.0007 in) 0.012 mm (0.0005 in) 0.020 mm (0.0008 in) 0.034 mm (0.0013 in)
2.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.038 mm (0.0015 in) 0.026 mm (0.0010 in) 0.018 mm (0.0007 in) 0.030 mm (0.0012 in) 0.045 mm (0.0018 in)
3.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.066 mm (0.0026 in) 0.044 mm (0.0017 in) 0.030 mm (0.0012 in) 0.050 mm (0.0020 in) 0.080 mm (0.0031 in)
4.0M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.078 mm (0.0031 in) 0.053 mm (0.0021 in) 0.034 mm (0.0013 in) 0.060 mm (0.0024 in) 0.096 mm (0.0038 in)

Quantum ^M Accuracy 7-Axis	ISO 10360-12 Maximum Permissible Error (MPE)
2.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.042 mm (0.0017 in) 0.028 mm (0.0011 in) 0.020 mm (0.0008 in) 0.035 mm (0.0014 in) 0.060 mm (0.0024 in)
3.5M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.085 mm (0.0033 in) 0.055 mm (0.0022 in) 0.040 mm (0.0016 in) 0.060 mm (0.0024 in) 0.110 mm (0.0043 in)
4.0M length Volumetric Accuracy (EUni) Single Point Repeatability (SPAT) PSize PForm LDia	0.100 mm (0.0039 in) 0.065 mm (0.0026 in) 0.040 mm (0.0016 in) 0.080 mm (0.0031 in) 0.132 mm (0.0052 in)
Quantum ^M 7-Axis and Laser Line Probe Accuracy (ScanArm)	Maximum Permissible Error (MPE)
2.5M length Volumetric Accuracy (EUni)	0.063 mm (0.0025 in)
3.5M length Volumetric Accuracy (EUni)	0.100 mm (0.0039 in)
4.0M length Volumetric Accuracy (EUni)	0.115 mm (0.0045 in)

All ScanArm values represent Maximum Permissible Error (MPE) in accordance with ISO 10360-8 Annex D.

For more information, see “ISO 10360 Standard” on page 114.

Chapter 8: Configuring the Quantum in CAM2 Measure

This chapter describes the operation of your Quantum with CAM2 Measure v10, or later. Most of these commands start items from the FaroArm driver and are available in other software packages. For more information in starting these commands in other software packages, see the FaroArm section in your software manual.

The DEVICE CONTROL panel contains all the commands for configuring the Quantum. In Measure choose **Device Control Panel** on the **Devices** tab to show the panel. You can also press the **P** hot key on the keyboard.

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Device Control Panel

The DEVICE CONTROL panel contains a list of all active devices with the properties of each associated device.



Figure 8-1 Device Control Panel

Choose the Quantum 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**.

Ethernet and Wireless

If you are connecting to the computer using the Bluetooth, WLAN, or Ethernet, first connect using the FaroArm Manager. This creates a connection to CAM2 Measure. For more information, see “Bluetooth” on page 52, “WLAN” on page 53, or “Ethernet” on page 54.

Probe Management

From the DEVICE CONTROL panel, click **Probe Management** button to show the PROBES dialog box.

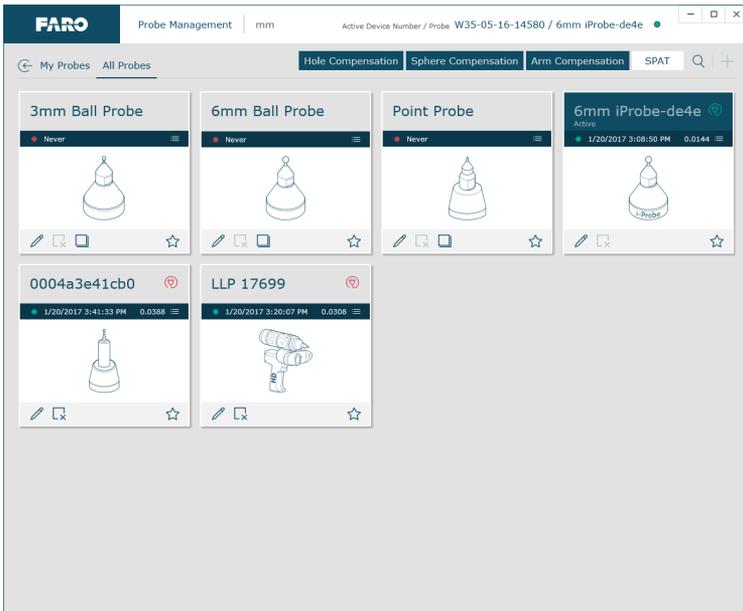


Figure 8-2 Probes dialog box

For more information, see “Probes” on page 55.

Hole Compensation

From the DEVICE CONTROL panel, click the **Probe Compensation Point** button to compensate the probe. *For more information, see “Hole Compensation Method” on page 63.*

Sphere Compensation

From the DEVICE CONTROL panel, click **Probe Compensation Sphere** to compensate the probe. *For more information, see “Sphere Compensation Method - 6-Axis” on page 67 or “Sphere Compensation Method - 7-Axis” on page 70.*

Hardware Configuration

From the DEVICE CONTROL panel, click **Hardware Configuration** to change the setup of the Quantum.

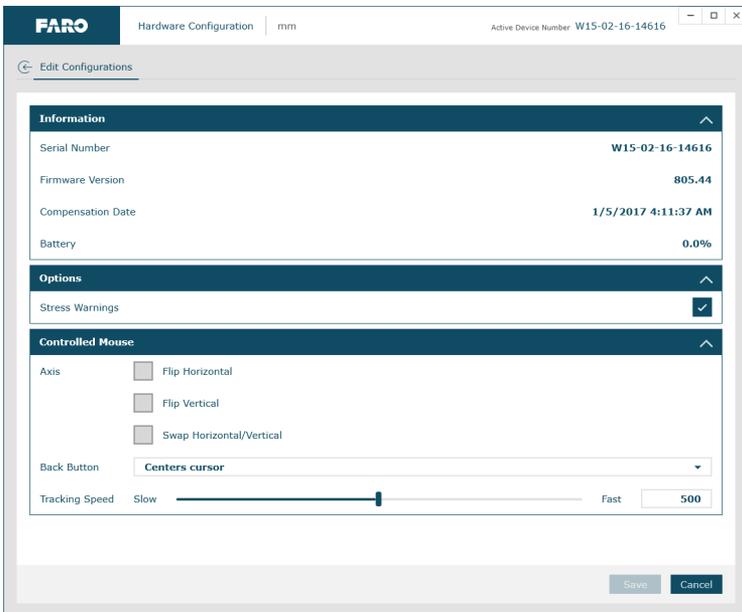


Figure 8-3 Diagnostics dialog box

For more information, see “Hardware Configuration” on page 76.

Diagnostics

From the DEVICE CONTROL panel, click **Diagnostics** to show the Quantum DIAGNOSTICS dialog box.

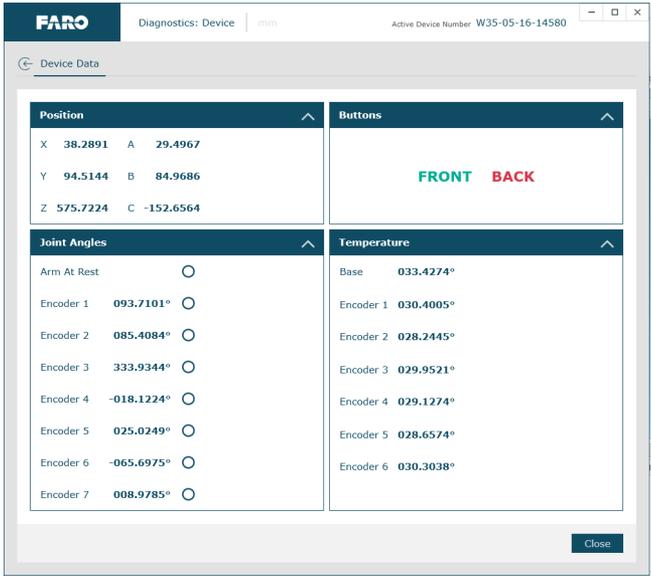


Figure 8-4 Diagnostics dialog box

For more information, see “Diagnostics” on page 80.

Temperature

From the DEVICE CONTROL panel, click **Temperature** to show the TEMPERATURE dialog box.

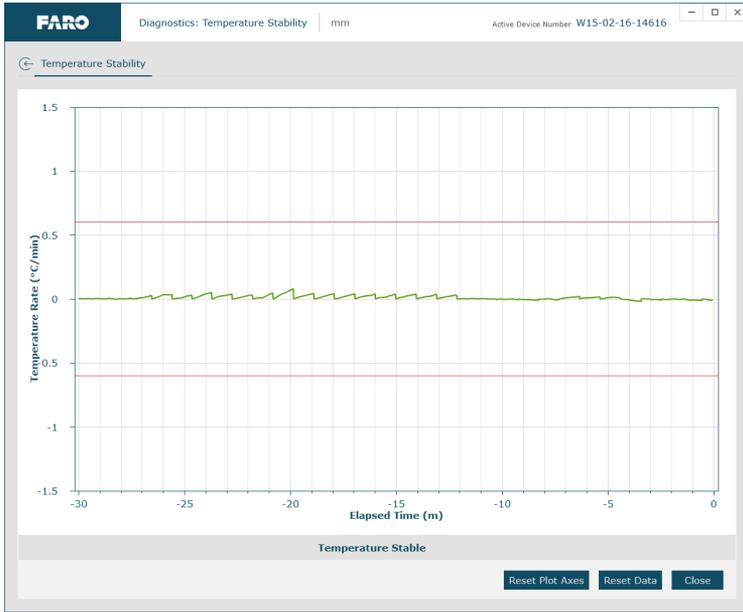


Figure 8-5 Temperature Stability dialog box

For more information, see “Temperature Stability” on page 84.

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 **Add Readings** command is started, or when any measure feature command is started in **Measure** mode.

In the MODE SETTINGS dialog:

- *Single Point:* press the green **Front** button, or the **G** key, to collect a single reading.

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

NOTE: If the current probe is a Laser Line Probe, it is best to use the TIME INTERVAL setting with a very small time interval. Setting the time interval to 0ms collects point data at the Quantum's maximum speed.

Measuring with the Quantum

Click the green **Front** button to collect a point reading. Click the red **Back** button to accept the collected readings, which is the Sampled End Click.

When measuring with a ball probe **1**, the location of the center of the probe records as a point each time you press the green **Front** button. Because each probe has a known diameter, there is a known distance between the center of the probe and the outer edge of the probe. This distance needs to be specified (projected) for the point to record in the correct location.

The distance between the probe point of contact **2** with the surface being measured and the center of the probe **3** is known as Probe Offset **4**. This transfer of the point from the center of the probe to the correct location is known as probe compensation.

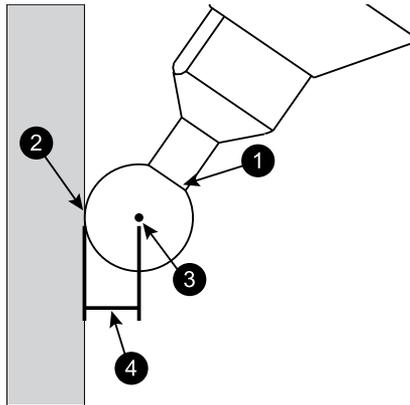


Figure 8-6 Measuring with the Ball Probe

Adding Readings

Use commands to control the Quantum instead of hardware buttons. Buttons (and their associated hot keys) on the MEASUREMENT panel are used for recording a reading (**G** key), recording an end click (**H** key), and removing the last reading (Backspace key).

You can also click the icons in the MEASUREMENT panel.

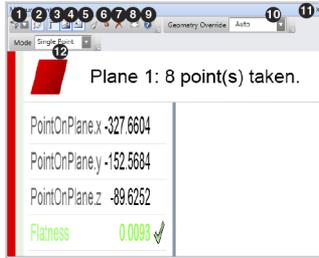


Figure 8-7 Measurement Panel

- 6  **Record Measurement**
- 7  **Record End Click**
- 8  **Remove Last Reading**

For more information, see the *Measurement Panel* section of the *Measure* chapter in the CAM2 Measure manual.

Technical Support

FARO Technologies, Inc. is committed to providing the best technical support to our customers. Our Service Policy is in *Appendix C: FARO 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 Knowledge Base. 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 7:00 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)

Mexico:

001-866-874-1154

Europe:

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

Asia:

1800 511 1360, +65 6511 1350 (Worldwide)

Japan:

0120.922.927, +81 561 63 1411 (Worldwide)

China:

400.677.6826, +86 21 6191 7600 (Worldwide)

India:

1800.1028456, +91-1146465656 (Worldwide)

Thailand:

+662.7441273-6 (Worldwide)

Korea:

+82.51.662.3413 (Worldwide)

Fax

North America:

+1 407 562 5294

Europe:

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

Asia:

65 65430111

Japan:

+81 561 63 1412

China:

+86 021 61917600

India:

+91-11-46465660

Thailand:

+662.7443178

Korea:

+82.51.941.8170

E-Mail

North America:

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China:

supportchina@faro.com

India:

supportindia@faro.com

Thailand:

supportthailand@faro.com

Korea:

supportkorea@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 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, sublicense, 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 LICENSOR 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 C: FARO Products Service Policy*.

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 MAINTENANCE/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.

d) Replacement parts used for repair may be new, refurbished, or contain refurbished materials.

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 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: FARO 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: FARO 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 at any FARO Service Center.
2. Factory repairs are targeted for completion within 7 (FaroArms, Laser Line Probe and Freestyle), 14 (Laser Trackers and Laser Scanners), or 10 (3D Imagers) working days of FARO's receipt of the defective item. The customer is responsible for returning the hardware to a FARO Service Center in the original packing container or custom case.
3. FARO will return the hardware via 2-day service within the continental United States. Outside the continental United States, FARO will return the hardware to the customs broker via 2-day service. Expedited service can be arranged at the customer's expense.
4. Upon expiration of the original warranty, a Supplemental Service Plan may be purchased and renewed on an annual basis for any FARO-manufactured hardware products, as long as material and resources are available.
5. All Supplemental Service Plans will be due for renewal one year and one day from the day the FARO-manufactured hardware is shipped from FARO.
6. Please contact FARO Customer Service to transfer the warranty. The original warranty and Supplemental Service Plans are transferable to subsequent owners under the following conditions:

- The FaroArm is currently under the original warranty and Supplemental Service Plan.
- The new owner is, or becomes, a certified user.
- FARO Customer Service is informed of and approves the transfer.

Upon approval by FARO Customer Service, the new owner will receive a FARO Transfer of Original Warranty or Service Plan agreement form executed by FARO.

7. Replacement parts used for repair may be new, refurbished, or contain refurbished materials.

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 ships the product to a FARO Service Center with the service number on the label along with payment or a corporate purchase order for system testing and evaluation, which includes compensation and calibration.
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. The customer is responsible for all shipping charges to and from FARO, including import and export fees for international customers.
5. FARO will continue to repair FARO-manufactured hardware products as long as material and resources are available.
6. Replacement parts used for repair may be new, refurbished, or contain refurbished materials.

FARO Software

FARO's warranty may differ depending on the Software you are utilizing. Please consult your software warranty or contact FARO customer service to determine the warranty conditions for your particular software.

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 operator's certification (see *Certification Requirements* section below for more details).
2. The fee schedules for advanced additional training courses can be obtained from Customer Service, or the Sales department.

Certification Requirements

An 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 operators, FARO has instituted an Operator Certification program, wherein 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 operator of the product. 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, please contact your local FARO office.

Repair Fee Schedule

(Out of Warranty/Maintenance 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, compensation and calibration, and applies to all FARO-manufactured hardware. 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 calibration. Recertification will be performed on an “as needed” basis.

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



Transfer of Original Warranty or Service Plan Agreement

(SELLER'S CORPORATE, BUSINESS UNIT, OR INDIVIDUAL NAME AS APPLICABLE),
hereby waives all rights under the warranty service policy for:

Hardware Device Serial Number _____
Additional Hardware Device Serial Number _____
Computer Service Tag Number _____
purchased originally on _____ (DATE).

(BUYER'S CORPORATE, BUSINESS UNIT, OR INDIVIDUAL NAME AS APPLICABLE),
hereby assumes all rights and obligations of the Hardware Warranty/Maintenance from
_____ (DATE OF TRANSFER).

This transfer is only valid under the following conditions:

1. The FaroArm is currently under warranty/maintenance.
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, BUSINESS UNIT, OR INDIVIDUAL NAME AS APPLICABLE)	_____ (PRINT BUYER'S CORPORATE, BUSINESS UNIT, OR INDIVIDUAL NAME AS APPLICABLE)
X _____	X _____
_____ (PRINT NAME OF SIGNATORY)	_____ (PRINT NAME OF SIGNATORY)

FARO Technologies, Inc.

Approved by X _____

(PRINT NAME OF SIGNATORY)

Buyer's Contact Information:

Company _____
Address _____
Address _____
City _____ State _____ Zip _____
Phone Number _____ E-mail _____

Appendix D: FARO Service Policy

This Service Plan (hereinafter, 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 at any time. 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 provide.

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 cannot 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, including 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 in accordance with a particular update plan specific to the software.

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. including all subsidiaries, affiliates, divisions and related companies.

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

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

2.04 “System” means a combination of the FARO-manufactured FaroArm, optional parts associated therewith, the Software, and the Computer.

2.05 “Hardware” means the FARO-manufactured product and all associated optional parts, and the Computer if provided by FARO.

2.06 “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 Product.

- 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.
 - FARO will return the hardware via 2 day service within the continental United States.
 - Outside the continental United States, FARO will return the hardware to the customs broker via 2 day service.
 - Expedited service can be arranged at the customer's expense.
- All reasonable efforts will be made to keep the service repair time within 7 (FaroArm), or 14 (Laser Tracker and Laser Scanner) working days. The equipment will be returned via 2-Day service; therefore, total service repair time will vary due to return shipping location.
- As the Product may be used with software packages not authored by FARO, this service plan is limited to covering 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

Product minus Computer

Covered

- All parts and labor for the Product falling under normal use as described in Appendix B.
- Annual compensation and calibration of the Product as necessary.

Not Covered

- Misuse
- Intentional Damage
- Wear and tear of probes, SMRs, target tooling and adapters, 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 provider's 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

- FARO's warranty may differ depending on the Software you are utilizing. Please consult your software warranty or contact FARO customer service to determine the warranty conditions for your particular software.

Not Covered

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

Extended Warranty with Loaner

The Extended Warranty with Loaner Plans additionally provide loaner equipment when service (and in some cases calibration) is required. All equipment shipping costs are paid for by FARO (both ways). FARO will make its best efforts to ship all loaner equipment within 24 hours of the receipt of the purchaser's 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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