FARO®
CAM2

FAROARM
USER GUIDE
AUGUST 2002

FARO Technologies, Inc. Internal Control File Locations:
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F:\CONTROL\RECORDS\05MANUFA\PARTSPEC\XH17-0257.pdf

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Chapter 1 : Introduction to the FaroArm

Chapter 1: Introduction to the FaroArm

Thank you for choosing FARO's Portable Measurement Arm - the FaroArm. This introduction contains detailed instructions on how to use your new serial communication-based Gold, Sterling, Bronze, or Silver FaroArm. Additional information about probes and important guidelines on maintaining your new FaroArm is also included. If you have any questions or need further instructions about any procedure, contact your Customer Service Representative at 800.736.2771 (North America), +1 407.333.3182 (Worldwide), or FAX +1 407.333.8056. You can also reach the Customer Service Applications and Training group via Internet e-mail at the following addresses:

- support@faro.com
- applications@faro.com
- training@faro.com

Visit the FARO Customer Service area on the Web at *www.faro.com* to search our technical support database. The database is available 24 hours a day, 7 days a week. Have your FaroArm Serial Number and FARO Customer Order Number available before connecting to the site.

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

ALL CAPITAL text	Indicates directory names, menu names, buttons, tabs, key names, acronyms, and modes.
`monospaced` text	Indicates alpha/numeric characters or values you enter in a field on the screen. For example, "Type `0.005` for the tolerance setting."
bold text	Anything you must enter exactly as it appears on your keyboard. For example, to type **a:install**, you would see text in bold type exactly as it should be entered.
SMALL CAPS text	Indicates dialogue box, icon names, and window names.

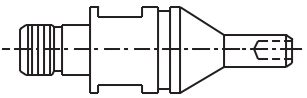
You may also see a few new words. It is important that you understand the meaning of these words before proceeding.

digitize	To record the XYZ coordinates of a point or location in 3D space. The word digitize is the same as the term *measure* when referring to points.
choose or select	Means that you are initiating an action. For example, "Select FILE < GRAPHICAL REPORTS < EXPORT DATA."
left-click, right-click, click, or press	Press and release the LEFT MOUSE button. Also used when referring to the FaroArm buttons. For example, "After selecting a file from the OPEN FILE dialogue box, *click* OK to open the file" or *"Press* ESC at anytime to cancel a command."
drag	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.

General Information

The FaroArm is a multiple-axis, articulated arm with a spherical working volume. Each joint has a rotary transducer. The signals from these transducers are processed and sent through the Serial communications cable, which attaches to the port in the back of the Computer.

FaroArm Probes



Four probes are supplied with the FaroArm. Each ball probe is stamped with the diameter of the ball (.25”, 6 mm, .125”, 3 mm, etc.). The FaroArm’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
- position and placement of the point on the object

FaroArm probes are manufactured with a common thread size. This thread size may vary with the location of your company and the age of the FaroArm. There are two thread sizes:

375" - 24	UNF Imperial Units - Older FaroArm
6M x 1	Metric Units - Newer FaroArm

FARO has a thread adapter so that older probes can be used with newer FaroArms. Contact FARO's Customer Service 800.736.2771 (North America), 407.333.3182 (Worldwide), or FAX 407.333.8056 for more details.

Installing Probes

The probe attaches to the 6M x 1 threaded handle at the end of the FaroArm. Use the 12 mm open-ended wrench you received with your FaroArm to install the probe. Special care should be taken to ensure the probe is properly seated.

> **WARNING**: Only *hand-tighten* the probe after you have installed it. *Do not* over-tighten the probe.

Renishaw Probe Installation and Operation

The Renishaw Probe installation and operation is optional. Renishaw probes collect points by touching a stylus to the part. The probe installation requires special hardware (FARO probe adapter). If the Renishaw Probe is purchased with the FaroArm, the adapter is installed at FARO's factory. FARO distributes three types of Renishaw probes - the TP-2, TP-20, and TPES probe. To attach a Renishaw probe to the FaroArm, see the *TP-2 Probe, TP-20 Probe Kit,* or the *TPES Probe* sections.

TP-2 Probe

To install the TP-2 Probe:

1 Screw the FARO adapter into the end of the FaroArm.

2 The second component is the Manual Probe Head (PH6). Screw the Manual Probe Head into the FARO adapter.

3 Next, screw the TP-2 probe into the FARO's Probe Head adapter with the C Spanner (S9) wrench.

4 Then, screw the Ruby Ball Stylus into the TP-2 probe with the Stylus Tool (S7). Do not under- or over-tighten any of the components.

5 Finally, connect the black cable to the FaroArm options port.

Measuring Software

The measuring software must be configured for the probe.

- In CAM2 Measure use the PROBES and switch the auxiliary port to the ON position by placing a check mark in the Aux Switch check box. *See "Probes" on page 43.*
- Calibrate the probe using the 1" sphere after installation. *See "1" Sphere Configuration" on page 46.*

TP-20 Probe Kit

The TP-20 Probe kit consists of a Renishaw (S1) C Spanner wrench, a Renishaw S9 double-ended C Spanner wrench, two Renishaw S7 stylus tools, a Renishaw CK200 cleaning kit, a magnetized TP-20 probe body, and three separate magnetized TP-20 probe modules, which connect to the TP-20 probe body. On the probe body and probe module there is a triangle, half-moon, and a square marker that must be matched for the probe to work properly. The TP-20 probe has a standard M8 x 1.25 screw connector designed to fit in a PH6 head/shank assembly. FARO modifies the integral probe cable to a six-pin, mini-din connector with a few resistors added. FARO also removes the shank and connects the PH6 assembly to the Arm via a machined metal adapter (Renishaw

Probe Adapter). To tighten the probe adapter and the PH-6 to the FaroArm, use the spanner wrenches provided with the Renishaw TP-20 kit.

> **NOTE**: Some older models of the Renishaw Probe Adapter attach to the FaroArm using a standard open-ended Imperial or Metric wrench. If you are using an Imperial Renishaw Adapter made prior to February 1998, and you are not using the Imperial to Metric adapter, use an Imperial 1/2 in. wrench to tighten the PH-6 and Probe Adapter to the FaroArm.

In February 1998, FARO modified the screw-in thread pattern to the 6M x 1 (Metric) thread pattern. If you are using the Metric Renishaw Adapter, use the 12 mm wrench to tighten the PH-6 and Probe Adapter to the FaroArm. The 12 mm wrench is also used for the Imperial to Metric Probe Adapter.

Probe Modules for the TP-20 Probe

Probe modules are available 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.

- In CAM2 Measure use the PROBES and switch the auxiliary port to the ON position by placing a check mark in the Aux Switch check box. *See "Probes" on page 43.*
- Calibrate the probe using the 1" sphere after installation. *See "1" Sphere Configuration" on page 46.*

Some software packages have other probe options that must also be controlled. The Renishaw Probe is very sensitive and should be adjusted with an allen wrench inserted into the end of the probe. (See the *Renishaw User's Manual*.)

The probe digitizes a point when it is bumped. It digitizes multiple points when bounced off an object. Watch the red LED light on the probe and listen to the sounds of the Controller Box to ensure that only one point was digitized. The LED light turns off and the Controller Box sounds when a point is digitized. Pressing the BACK button confirms the point. Calibrate the probe using the 1in. sphere probe calibration technique after installation.

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

TPES Probe

The Renishaw TPES Probe is a single module designed to connect directly into the FaroArm. The TPES Probe Assembly has a standard M6 x 1 screw connector. The Renishaw TPES kit comes with a stylus, spanner wrench, and one Renishaw Ruby tip. Use the spanner wrench that comes with the kit to tighten the probe.

Measuring Software

The measuring software must be configured for the probe.

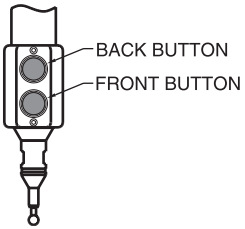
- In CAM2 Measure use the PROBES and switch the auxiliary port to the ON position by placing a check mark in the Aux Switch check box. *See "Probes" on page 43.*
- Calibrate the probe using the 1" sphere after installation. *See "1" Sphere Configuration" on page 46.*

Custom Probe Calibration

Any probe with a sphere or a point can be calibrated. See the *Probes* section in the *Devices Menu* for instructions on calibrating a probe.

FaroArm Handle Buttons

The FRONT button is used to collect data, and the BACK button to accept the data. The FRONT button is nearest the probe and the BACK button is nearest the handle. The 2-2-2 configuration has two sets of buttons, where the FRONT buttons and BACK buttons are redundant and wired together internally.



Auxiliary Port (7th Variable Options Port)

On the side of the handle, opposite the button, there is a six-pin connector that allows two channels of analog input into the FaroArm signal processing board. This is used for any number of analog input options, such as a conductance-based touch probe. The Gold series FaroArms have an additional five-pin connector on the back of the serial box controller. Auxiliary input voltage for #1 and #2 are [±4.5 volts].

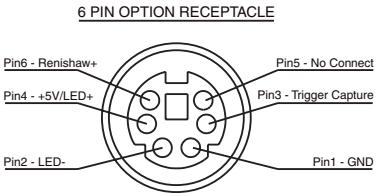


Figure 1-1 Auxiliary Port

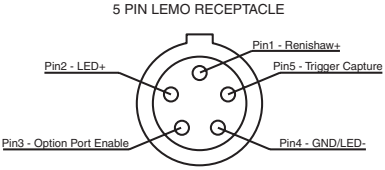


Figure 1-2 Gold Series Auxiliary Port

Precautions

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

- abuse, such as dropping or twisting at end stops
- moisture and high humidity
- excessive temperature changes without appropriate elapsed time

Your FaroArm can give you many years of service when treated with care.

The FaroArm Packing Contents

The following components and accessories are standard items shipped with every unit.

Gold Series - Packing List

- Shipping Case
- FaroArm Accessories Manual
- FaroArm
- Power Supply
- Three Probes
- Serial null modem cable
- FaroArm Cable (connectors #3 and #4)
- Surface Mount Plate

Sterling/Bronze Millennium Series - Packing List

- Shipping Case
- FaroArm Accessories Manual
- FaroArm
- 12v Power Supply
- Three Probes
- Serial null/modem cable
- FaroArm Cable (connectors #3 and #4)
- Clamping Ring and Spanner Wrench

Silver Series - Packing List

- Shipping Case
- FaroArm Accessories Manual
- FaroArm
- Power Supply
- One Factory Ball Probe
- Three Probes
- Serial null modem cable
- FaroArm Cable (connectors #3 and #4)
- Surface Mount Plate

Bronze Series - Packing List

- Shipping Case
- FaroArm Accessories Manual
- FaroArm
- 12v Power Supply
- One Factory Ball Probe
- Three Probes
- 25' 9-pin Serial Line
- 9 to 25 pin Serial Line Adapter
- Table Mount

NOTE: If a computer was ordered with your FaroArm, the Operator's Manual is shipped in the computer equipment box.

Optional Accessories

The *Accessories Manual* that comes with your FaroArm has all of the optional accessories that you can order from FARO's factory. 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 and include them with your FaroArm order, contact FARO's Customer Service 800.736.2771 (North America), 407.333.3182 (Worldwide), or FAX 407.333.8056.

Packing the FaroArm

The 7-axis *Gold FaroArm* and *Sterling/Bronze Millennium FaroArm* should be packed very carefully to prevent shipping damage.

Gold FaroArm

Pack the Power Module, Probe Case, and Surface Mount Plate, as

shown.

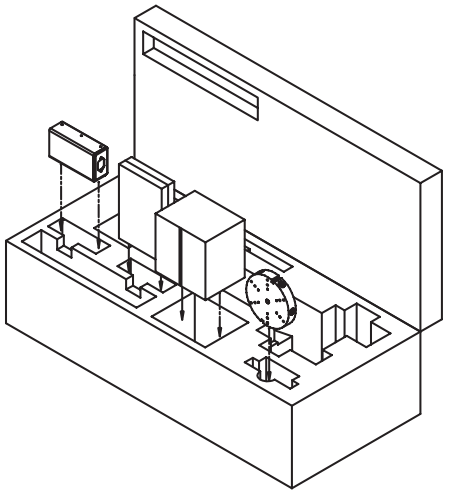


Figure 1-3 Gold Series Case

1 Rotate Tube 1 180° in the direction of the arrow about Axis 2.

2 Then rotate Transfer Case A 180° in the direction shown below.

3 Grab the FaroArm with both hands.

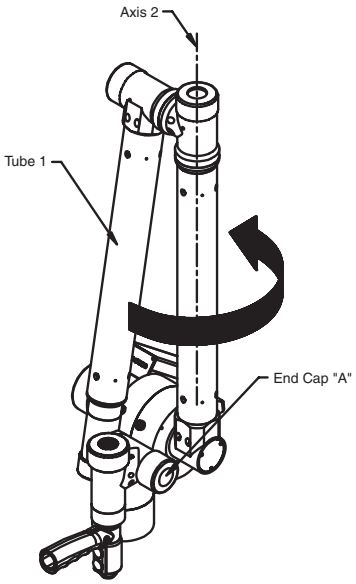


Figure 1-4 Tube Position

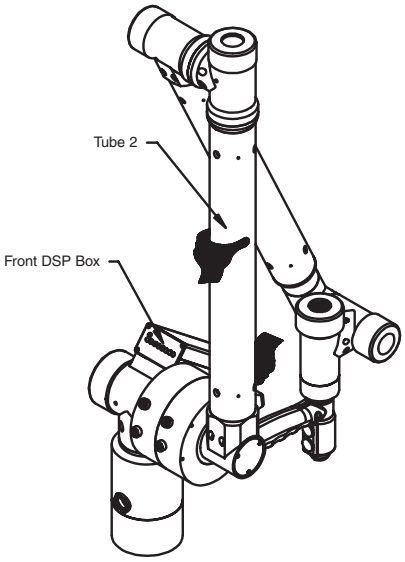


Figure 1-5 Hand Position

4 Insert the FaroArm into the case.

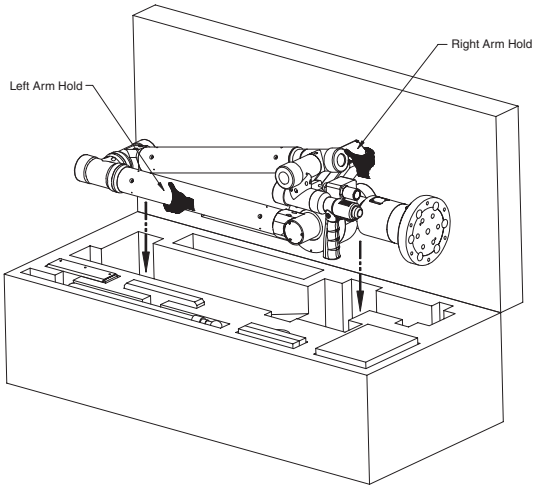


Figure 1-6 Gold FaroArm in Case

Sterling/Bronze Millennium FaroArm

Pack the Power Module, Probe Case, and Surface Mount Plate, as shown.

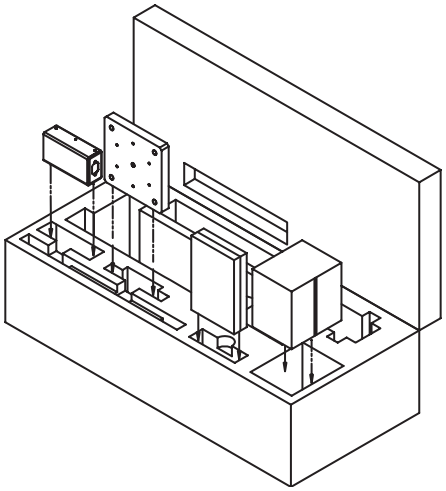


Figure 1-7 Sterling Series Case

1 Rotate Tube 1 180° in the direction of the arrow about Axis 1.

2 Rotate Transfer Case A 180° in the direction of the arrow about

Axis 2.

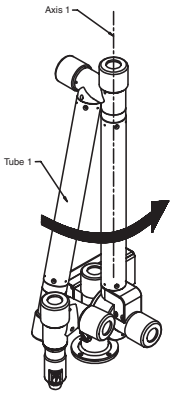


Figure 1-8 Rotate Tube 180 degrees about Axis 1

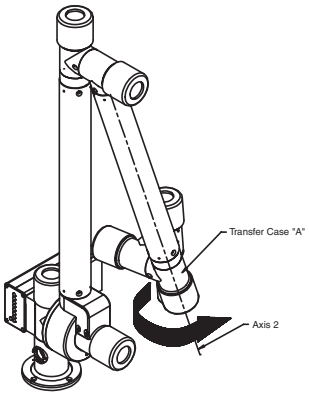


Figure 1-9 Rotate Transfer Case 180 degrees about Axis 2

3 Grab the FaroArm with both hands.

4 Insert the FaroArm into the case.

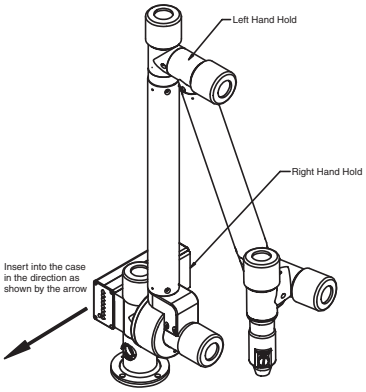


Figure 1-10 Hand Position on FaroArm

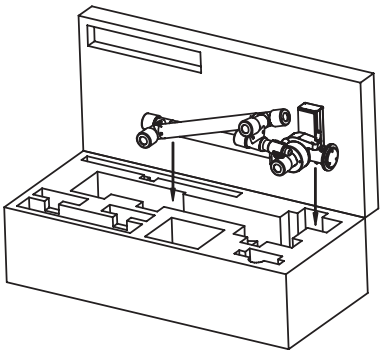


Figure 1-11 Insert into Case

Hardware Setup

Instructions for setting up the hardware for each type of FaroArm are located in the *Mounting the Base*, *Mounting Stiffness Test*, or the *Controller Serial Box* sections.

Mounting the Base

Each type of FaroArm has specific instructions for mounting the base.

Gold FaroArm

The counterbalance by the tension spring generates torque at the base of the FaroArm. So to achieve optimum machine accuracy, the mounting must meet certain requirements.

- Use FARO-supplied mounts. The torque for all mounting bolts is 100-inch pounds.
- Test the stability of the mount with a dial indicator to check for possible angular or lateral deflection after mounting the Arm. An angular deflection of the base must not exceed 20 micro inches/inch at this applied torque. The lateral deflection of the base must not exceed 0.001 inches at this applied lateral load.

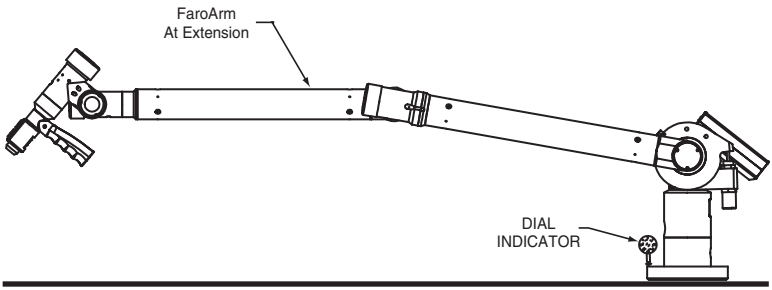


Figure 1-12 Mounting the Gold and Silver FaroArms

- Angular deflection <<: 20 micro inches/inch
- Lateral deflection <<: 0.001

The Gold FaroArm fastens to any flat and rigid surface through the surface mounting plate.

1 First, attach the surface mounting plate to any stable surface with four bolts.

2 Mount the Arm to the baseplate (with Arm attached). The baseplate can rotate 360°, but must be mounted securely before

operation.

3 Tighten all mounting bolts to 100-inch pounds.

Sterling/Bronze Millennium FaroArm

To fasten the Sterling and Bronze Millennium FaroArm:

1 Attach the 3.5" threaded ring and surface mount plate to any stable location.

2 Place the FaroArm on top of the 3.5” threaded ring.

3 Screw the threaded collar clamp onto the base of the Arm and the 3.5” threaded ring.

4 Use the spanner wrench to tighten the threaded collar clamp.

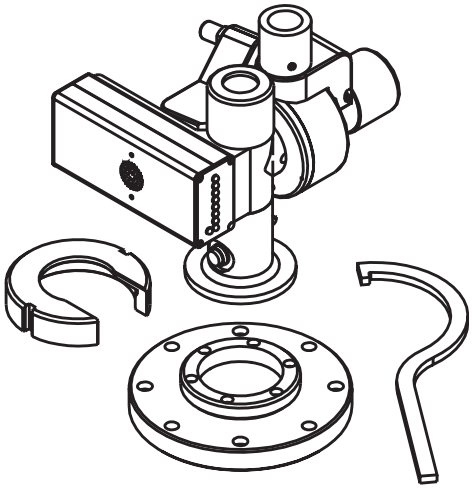


Figure 1-13 Mounting the Sterling FaroArm

Silver FaroArm

The counterbalance by the tension spring generates torque at the base of the FaroArm. So to achieve optimum machine accuracy, the mounting must meet certain requirements.

- Use FARO-supplied mounts. The torque for all mounting bolts

is 100-inch pounds.

- Test the stability of the mount with a dial indicator to check for possible angular or lateral deflection after mounting the Arm. An angular deflection of the base must not exceed 20 micro inches/inch at this applied torque. The lateral deflection of the base must not exceed 0.001 inches at this applied lateral load.
    - Angular deflection <<: 20 micro inches/inch

- Lateral deflection <<: 0.001

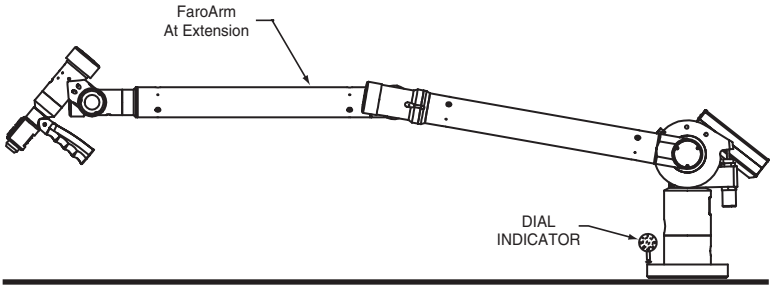


Figure 1-14 Mounting the Gold and Silver FaroArms

The Silver FaroArm fastens to any flat and rigid surface through the surface mount plate.

1 First, attach the surface mount plate to any stable surface with four bolts.

2 Mount the Arm to the baseplate (with Arm attached). The baseplate can rotate 360°, but must be mounted securely before operation.

3 Tighten all mounting bolts to 100-inch pounds.

Bronze FaroArm

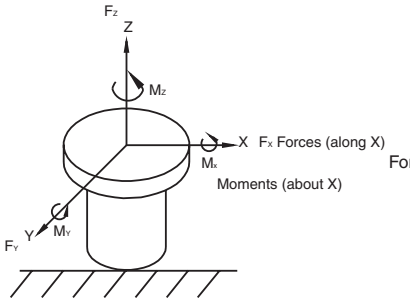
The portable table clamp fastens to any stable surface in the same manner as a C-clamp. It can also be permanently mounted to any stable surface. The 3.5" threaded ring can be removed from the table mount and attached to an alternative clamp or a permanent location. Most surveying or other portable instrument stands have adapters for the 3.5" thread.

Mounting Stiffness Test

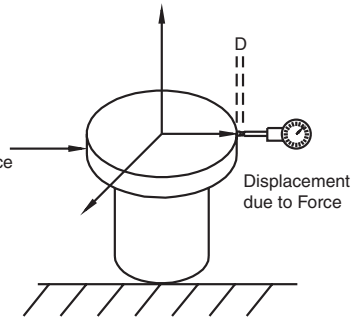
The FaroArm is portable and can be mounted in a variety of environments. The FaroArm is counterbalanced, and it is the nature of counterbalancing that reaction forces may exist in the mounting due to the applied forces generated by the counterbalancing mechanism. The reaction forces will result in deformations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

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

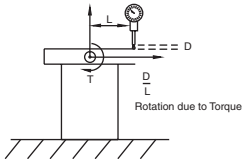
The deformation due to the translation force can be measured. You must apply forces (lb. or N) using a calibrated load cell at the mounting interface to the maximum level required and measure the associated deformation (in. or mm). The torsional forces or moments at the base are generated by using a calibrated torque wrench. The deformations can be described as a slope (in./in. or mm/mm) and can be measured. The deformations must not exceed the deformation reported at certification.



Forces Encountered due to Counterbalancing



Displacement due to Force



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.

Controller Serial Box

The Controller Serial Box contains highly sophisticated signals and numerical processors that read the raw data and convert this raw data into dimensional coordinates.

Sterling/Bronze Millennium FaroArm

The components of the Sterling and Bronze Millennium Series Controller Serial Box are described in the following sections:

- *Signal and Numeric Processing*
- *Cable Connections*
- *Error and Status Indicator Panel*
- *Referencing Encoder*

Signal and Numeric Processing

Inside the Controller Box is an EEPROM chip for updating controller software. The Controller Box automatically senses worldwide, AC input 110/220 VAC, 50-60 HZ.

Cable Connections

The null modem serial cable connects the Power Supply Box serial port and the host computer's serial port. The six-pin, round locking cable connects the FaroArm's base (on or off) labeled #4 and the #3 port on the Power Supply Box.

Error and Status Indicator Panel

The front panel of the Controller Box has nine LEDs, one green LED for the power indicator, one red LED for error indication, and seven red LEDs that are error indicators. Volume control is handled through the software. *See "Hardware Configuration" on page 42.*

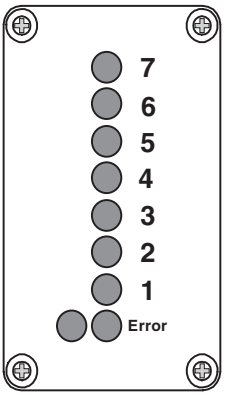


Figure 1-15 Sterling Controller Front View

Referencing Encoder

The six, transducer-numbered LEDs are illuminated when the power is turned on to the Controller Box. In a systematic manner, rotate links 1 through 6 until the lights on the front of the Controller Box turn off. This takes the incremental encoders through their reference positions.

> **NOTE:** The FaroArm does not operate properly until all seven red LEDs are off.

Gold FaroArm

The components of the Gold Series Controller Serial Box are described in the following sections:

- *Signal and Numeric Processing*
- *Cable Connections*
- *Error and Status Indicator Panel*
- *Referencing Encoder*

Signal and Numeric Processing

Inside of the box is an EEPROM chip for updating controller software. The Controller Box is connected to a Power Supply Box that automatically senses worldwide, AC input 110/220 VAC, 50-60 HZ 50W.

Cable Connections

The null modem serial cable connects the Power Supply Box serial port and the host computer's serial port. The six-pin, round locking cable connects the FaroArm's base (on or off) labeled #4 and the #3 port on the Power Supply Box.

Error and Status Indicator Panel

The front panel of the Controller Box has nine LEDs, one green LED for the power indicator, one red LED for error indication, and seven red LEDs that are error indicators. Volume control is handled through the software. *See "Hardware Configuration" on page 42.*

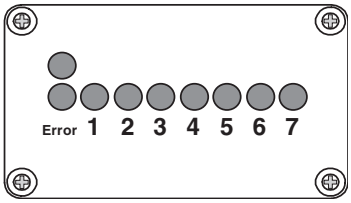


Figure 1-16 Gold Controller Front View

Referencing Encoder

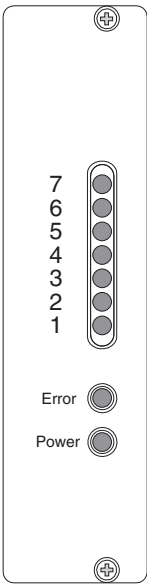
The six, transducer-numbered LEDs are illuminated when the power is turned on to the Controller Box. Rotate links 1 through 6 systematically, until the lights on the front of the Controller Box turn off. This takes the incremental encoders through their reference positions.

> **NOTE**: The FaroArm does not operate properly until all seven red LEDs are off.

Bronze FaroArm

The components of the Bronze Series Controller Serial Box are described in the following sections:

- *Signal and Numeric Processing*
- *Cable Connections*
- *Error and Status Indicator Panel*



Signal and Numeric Processing

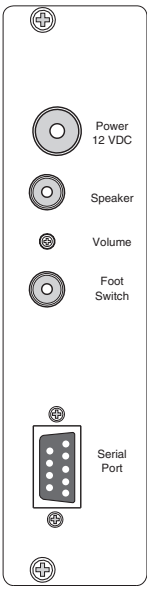
Inside of the box is an EEPROM chip for updating controller software. The Controller Box automatically senses worldwide, AC input 110/220 VAC, 50-60 HZ.

Cable Connections

The serial cable connects the Controller Box (via the serial port) and the host computer serial port. The external 12v. Power Supply connects to the power port in the back of the Controller Box.

Error and Status Indicator Panel

The front panel of the Controller Box has nine LEDs - one green LED for the power indicator, one red LED for error indication, and seven red LEDs that are error indicators.



Silver FaroArm

The components of the Silver Series Controller Serial Box are described in the following sections:

- *Signal and Numeric Processing*
- *Cable Connections*
- *Error and Status Indicator Panel*
- *Referencing Encoder*

Signal and Numeric Processing

Inside of the box is an EEPROM chip for updating controller software. The Controller Box is connected to a Power Supply Box, which automatically senses worldwide, AC input 110/220 VAC, 50-60 HZ 50W.

Cable Connections

The null modem serial cable connects the Power Supply Box serial port and the host computer's serial port. The six-pin, round locking cable connects the FaroArm's base (on or off) labeled #4 and the #3 port on the Power Supply Box.

Error and Status Indicator Panel

The front panel of the Controller Box has nine LEDs - one green LED for the power indicator, one red LED for error indication, and seven red LEDs that are error indicators.

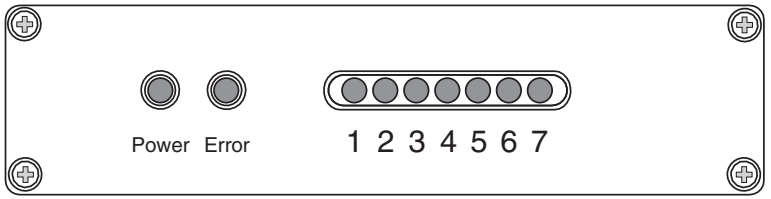


Figure 1-17 Silver Controller Front View

Referencing Encoder

The six, transducer-numbered LEDs are illuminated when the power is turned on to the Controller Box. In a systematic manner, you must rotate links 1 through 6 until the lights on the front of the Controller Box turn off. This takes the incremental encoders through their reference positions.

NOTE: The FaroArm does not operate properly until all seven red LEDs are off.

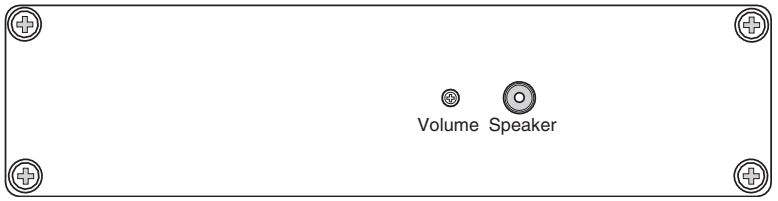


Figure 1-18 Silver Controller Rear View

Host Computer

The Controller Box output is accepted through any host computer serial port 1 or 2 with a null modem cable.

1 1456 FaroArm Cable.

2 Power Supply.

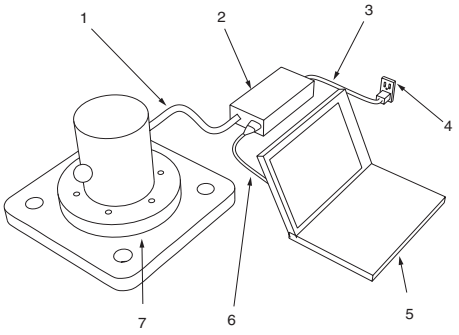
3 Power Cable.

4 Power Outlet.

5 Lap Top Computer.

6 Null Modem Cable.

7 FaroArm.



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. The FaroArm employs a software/hardware solution (patents pending) where a semiconductor temperature sensor is built into the device at its point of largest mass. This location is critical since it is the last to stabilize after any temperature change.

The temperature measured is compared to the reference temperature stored on the onboard EEPROM (Electrically Erasable Programmable Read-only Memory). The difference in temperature is then applied to the mathematical formulas or kinematics, which defines the position of the Arm in three-dimensional space. Link length corrections are made constantly by the onboard processor, which adjusts the kinematics and constantly adapts the output to changing environmental temperature.

The formulations for the FaroArm are simple since the device is uniformly constructed of Aluminum.

However, because different components heat or cool at different rates, the device is expected to reach a steady state temperature within a ±5 degree (Celsius) bandwidth for five minutes before measurements can be taken. For convenience, the Controller Box is programmed to beep once when the temperature exceeds a ±5 degree bandwidth and it sends a temperature change error command through the serial line. 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.

FaroArm Accuracy

The accuracy testing standard is the North American ASME or European ISO standard. The ANSI B89 describes accuracy as total bandwidth error. This bandwidth can apply to single-point repeatability, linear displacement accuracy, or volumetric performance. Single-point repeatability is measured on a reference sphere or by using a hard probe in a reference hole. Linear displacement accuracy is measured using step gages, and volumetric performance is measured with a single-point repeatability test. Measurements are well distributed in all regions of the working volume. Instrument accuracy can also be described statistically in standard deviations or Sigma. One Sigma error band contains 67.3%, the 2 Sigma contains 95.5%, and the 3 sigma contains 99.7% of all measurement errors.

FARO's Sterling Series Model 04 Single-point Repeatability 2 Sigma = ±.0020" or ±.051 mm

FARO's Sterling Series Model 06 Single-point Repeatability 2 Sigma = ±.0033" or ±.084 mm

FARO's Sterling Series Model 08 Single-point Repeatability 2 Sigma = ±.0040" or ±.102 mm

FARO's Sterling Series Model 10 Single-point Repeatability 2 Sigma = ±.0066" or ±.168 mm

FARO's Gold Series Model 04 Single-point Repeatability 2 Sigma = ±.0010" or ±.025 mm

FARO's Gold Series Model 06 Single-point Repeatability 2 Sigma = ±.0016" or ±.041 mm

FARO's Gold Series Model 08 Single-point Repeatability 2 Sigma = ±.0020" or ±.051 mm

FARO's Gold Series Model 10 Single-point Repeatability 2 Sigma = ±.0033" or ±.084 mm

FARO's Gold Series Model 12 Single-point Repeatability 2 Sigma = ±.0047" or ±.119 mm

FARO's Bronze Series Model 06 & 08 Single-point Repeatability 2 Sigma = ±.012" or ±.305 mm

FARO's Bronze Series Model 10 Single-point Repeatability 2 Sigma = ±.016" or ±.406 mm

FARO's Silver Series Model 06 & 08 Single-point Repeatability 2 Sigma = ±.003" or ±.076 mm

FARO's Silver Series Model 12 Single-point Repeatability 2 Sigma = ±.007" or ±.178 mm

FARO's Bronze Millennium Series Model 04 Single-point Repeatability 2 Sigma = ±.0040" or ±.102 mm

FARO's Bronze Millennium Model 06 Single-point Repeatability 2 Sigma = ±.0066" or ±.168 mm

FARO's Bronze Millennium Model 08 Single-point Repeatability 2 Sigma = ±.0080" or ±.204 mm

FARO's Bronze Millennium Model 10 Single-point Repeatability 2 Sigma = ±.0132" or ±.336 mm

NOTE: To maintain this accuracy, correctly mounting the FaroArm is very important. See *"Hardware Setup" on page 13* for procedures on mounting the FaroArm.

Loss of a Degree of Freedom

In a working volume of the FaroArm there can be a loss of a degree of freedom (natural rotation of transfer case). With this loss, bending occurs on the transfer tubes of the FaroArm causing a movement of the probe position that cannot be recorded by the Arm's encoder system. Measurement results taken in these positions are not accurate. This condition is never encountered in the calibration of the FaroArm.

Common areas of measurement where this loss occurs are:

- when an encoder has reached a hard end-stop
- directly above the FaroArm
- in close to the base of the FaroArm

The FaroArm 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 a FaroArm where a degree of freedom has been lost.

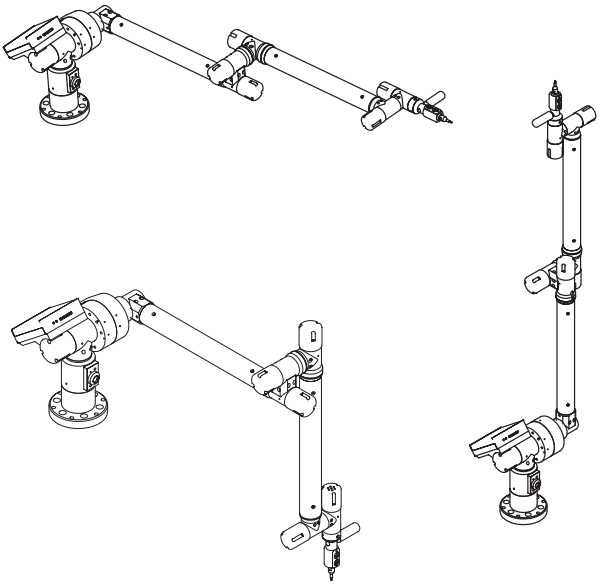


Figure 1-19 Loss of a Degree of Freedom

Preventive Maintenance

It is recommended that you check your FaroArm at least once a month. This enables you to spot trouble before it starts and helps provide you with an efficient measuring system.

FaroArm IP Rating

The IP waterproofing rating for the FaroArm is DIN40 050-IP53.

Maintenance of the FaroArm

The FaroArm is a precision instrument that contains many sensitive components, and it should be handled with care. Here are some procedures you should take to prevent problems from developing with your system:

- Place a dust cover over the FaroArm and the Controller Box when it is not in use.
- Clean with dry, dust cloth. For heavy, dirt buildups use a very small amount of solvent and gently clean the Arm. Be very careful not to bend the Arm while cleaning. Safety Solvent #13, by Hernon Manufacturing Inc., or something similar, is recommended.
- Check the cables for damage to outside insulation, connectors, and pins.
- Do not lubricate the FaroArm.

The FaroArm is calibrated at FARO's factory. So it should only need to be recalibrated after the unit has been subjected to a shock that removes metal or causes bending of the FaroArm. Follow the procedures below to verify the accuracy of the FaroArm.

- Calibrate a ¼" or 6 mm Ball Probe.
- Complete a Single Point certification. If it fails, print the results and repeat the certification two more times. Print all of the results.

- Contact FARO's Customer Service 800.736.2771 (North America), 407.333.3182 (Worldwide), or FAX 407.333.8056.

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 two materials, one of which is a nonconductor.

ESD - Bronze Series

This unit does not always respond to ESD, depending on the polarity and intensity of the electrostatic discharge. Although this unit cannot be physically damaged by ESD, extra care and proper ESD procedures still must be observed and followed when handling this unit.

If an error occurs in the unit due to ESD, check the Error Message displayed on the screen and follow the steps below to resume normal operation.

If the message is:

Timeout Error on Serial Line

1 Press any key on the keyboard and the unit should be back to normal operation.

No Transducer Voltage Error

1 Reboot the unit first by unplugging the power cord from the wall outlet. Wait at least five seconds before plugging it back into the outlet.

2 Press any key on the keyboard and the unit should be back to its normal operation.

NOTE: All data will be lost because you shut down the power, so a new set of data should be collected.

ESD - Gold, Silver, and Sterling Series

These units do not always respond to ESD, depending on the polarity

and intensity of the electrostatic discharge. Although these units cannot be physically damaged by ESD, extra care and proper ESD procedures still must be observed and followed.

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

If the message displayed is:

Transducer out of Calibration

1 Press any key on the keyboard and the unit should be back to its normal operation.

NOTE: If you experience anything out of normal operation, reboot the unit by unplugging the 20 ft. cable from the power supply module. Wait for at least five seconds before powering the unit. This should restore communication with the host PC.

FaroArm Power Supply

All servicing should be referred to qualified service personnel.

Rated Voltage:	110 - 230V ~ 50 - 60 Hz
Voltage Tolerance:	+10% or -10%
Rated Input:	0.5A - 0.263A
Sec. Voltage:	+12 VDC
Sec. Current:	2.08A Max
Pollution Category:	2
Installation Category:	II

CAUTION
(INDOOR USE ONLY)

Supplying Power to the FaroArm

Place the FaroArm in an area with a properly grounded outlet receptacle. The input power plug is the disconnect device to remove

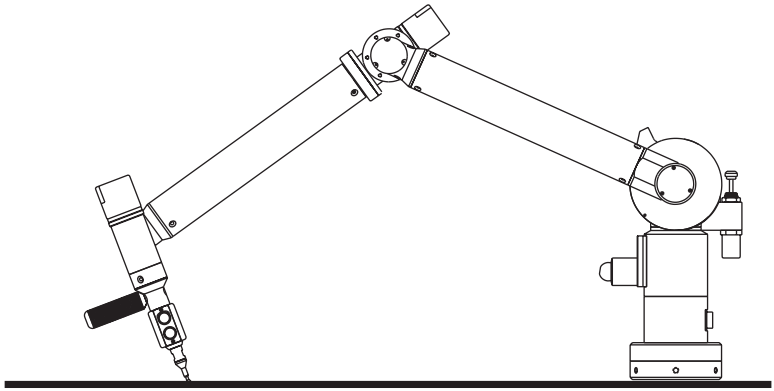
power from the unit.

Select the proper power supply cord intended for installation in a protected environment.

- 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 0.75mm^2 minimum cross-sectional area, each with a molded-on plug cap marked with proper agency marking for the country where it will be used.

Certification

NOTE: When certifying a FaroArm, do not allow any of the transfer cases to reach their end stop rotation positions because bending can occur in the measuring device and possibly create inaccurate results.



Certification using the FARO Ball Bar

Operational Errors

Many of the error messages listed in this section are not error conditions, but decision-making situations you will encounter when using FaroArm. When you are familiar with FaroArm, most of these

decisions will no longer be problems, but routine aspects of using the program. Be aware that certain errors, although not fatal, lead to errors in data processing if not corrected. For example, an error in alignment setup causes inaccurate datum collection.

The following list contains some of the common messages that may occur while you are working with FaroArm. The messages are in alphabetical order.

DSP Beep Codes

Normal

2 QUICK 6000Hz BEEPS FOLLOWED BY 2 SLOWER 4000Hz BEEPS 1 SECOND LATER
normal boot, SERIND is loaded and ready
2 QUICK 6000Hz BEEPS FOLLOWED BY 3 VERY QUICK 4000Hz BEEPS
loader program is staying resident and ready

Errors

2 QUICK 6000Hz BEEPS FOLLOWED BY 2 1500Hz BEEPS issued by SERIND
SERIND detected a configuration error, not calculating any positions, will respond to serial commands and report errors.
2 QUICK 6000Hz BEEPS FOLLOWED BY 3 1500Hz BEEPS THAT REPEAT EVERY SECOND
issued by loader
DMA failure, stuck in infinite loop
4 1500Hz BEEPS THAT REPEAT EVERY 1 SECOND
issued by MEMCHK
SRAM failure, stuck in infinite loop

LED Error Patterns

ERROR CODE	LED PATTERN 1	2	3	4	5	6	7	ERROR CODE	LED PATTERN 1	2	3	4	5	6	7	ERROR CODE	LED PATTERN 1	2	3	4	5	6	7
1	○	○	○	○	○	○	●	22	○	○	●	○	●	●	○	43	○	●	○	●	○	●	●
2	○	○	○	○	○	●	○	23	○	○	●	○	●	●	●	44	○	●	○	●	●	○	○
3	○	○	○	○	○	●	●	24	○	○	●	●	○	○	○	45	○	●	○	●	●	○	●
4	○	○	○	○	●	○	○	25	○	○	●	●	○	○	●	46	○	●	○	●	●	●	○
5	○	○	○	○	●	○	●	26	○	○	●	●	○	●	○	47	○	●	○	●	●	●	●
6	○	○	○	○	●	●	○	27	○	○	●	●	○	●	●	48	○	●	●	○	○	○	○
7	○	○	○	○	●	●	●	28	○	○	●	●	●	○	○	49	○	●	●	○	○	○	●
8	○	○	○	●	○	○	○	29	○	○	●	●	●	○	●	50	○	●	●	○	○	●	○
9	○	○	○	●	○	○	●	30	○	○	●	●	●	●	○	51	○	●	●	○	○	●	●
10	○	○	○	●	○	●	○	31	○	○	●	●	●	●	●	52	○	●	●	○	●	○	○
11	○	○	○	●	○	●	●	32	○	●	○	○	○	○	○	53	○	●	●	○	●	○	●
12	○	○	○	●	●	○	○	33	○	●	○	○	○	○	●	54	○	●	●	○	●	●	○
13	○	○	○	●	●	○	●	34	○	●	○	○	○	●	○	55	○	●	●	○	●	●	●
14	○	○	○	●	●	●	○	35	○	●	○	○	○	●	●	56	○	●	●	●	○	○	○
15	○	○	○	●	●	●	●	36	○	●	○	○	●	○	○	57	○	●	●	●	○	○	●
16	○	○	●	○	○	○	○	37	○	●	○	○	●	○	●	58	○	●	●	●	○	●	○
17	○	○	●	○	○	○	●	38	○	●	○	○	●	●	○	59	○	●	●	●	○	●	●
18	○	○	●	○	○	●	○	39	○	●	○	○	●	●	●	60	○	●	●	●	●	○	○
19	○	○	●	○	○	●	●	40	○	●	○	●	○	○	○	61	○	●	●	●	●	○	●
20	○	○	●	○	●	○	○	41	○	●	○	●	○	○	●	62	○	●	●	●	●	●	○
21	○	○	●	○	●	○	●	42	○	●	○	●	○	●	○	63	○	●	●	●	●	●	●

● INDICATES FLASHING LED

Figure 1-20 Error Codes, 7 LED Controller

ERROR CODE	LED PATTERN 1	2	3	4	5	6	ERROR CODE	LED PATTERN 1	2	3	4	5	6	ERROR CODE	LED PATTERN 1	2	3	4	5	6
1	●	○	○	○	○	○	22	○	●	●	○	●	○	43	●	●	○	●	○	●
2	○	●	○	○	○	○	23	●	●	●	○	●	○	44	○	○	●	●	○	●
3	●	●	○	○	○	○	24	○	○	○	●	●	○	45	●	○	●	●	○	●
4	○	○	●	○	○	○	25	●	○	○	●	●	○	46	○	●	●	●	○	●
5	●	○	●	○	○	○	26	○	●	○	●	●	○	47	●	●	●	●	○	●
6	○	●	●	○	○	○	27	●	●	○	●	●	○	48	○	○	○	○	●	●
7	●	●	●	○	○	○	28	○	○	●	●	●	○	49	●	○	○	○	●	●
8	○	○	○	●	○	○	29	●	○	●	●	●	○	50	○	●	○	○	●	●
9	●	○	○	●	○	○	30	○	●	●	●	●	○	51	●	●	○	○	●	●
10	○	●	○	●	○	○	31	●	●	●	●	●	○	52	○	○	●	○	●	●
11	●	●	○	●	○	○	32	○	○	○	○	○	●	53	●	○	●	○	●	●
12	○	○	●	●	○	○	33	●	○	○	○	○	●	54	○	●	●	○	●	●
13	●	○	●	●	○	○	34	○	●	○	○	○	●	55	●	●	●	○	●	●
14	○	●	●	●	○	○	35	●	●	○	○	○	●	56	○	○	○	●	●	●
15	●	●	●	●	○	○	36	○	○	●	○	○	●	57	●	○	○	●	●	●
16	○	○	○	○	●	○	37	●	○	●	○	○	●	58	○	●	○	●	●	●
17	●	○	○	○	●	○	38	○	●	●	○	○	●	59	●	●	○	●	●	●
18	○	●	○	○	●	○	39	●	●	●	○	○	●	60	○	○	●	●	●	●
19	●	●	○	○	●	○	40	○	○	○	●	○	●	61	●	○	●	●	●	●
20	○	○	●	○	●	○	41	●	○	○	●	○	●	62	○	●	●	●	●	●
21	●	○	●	○	●	○	42	○	●	○	●	○	●	63	●	●	●	●	●	●

● INDICATES FLASHING LED

Figure 1-21 Error Codes, 6 LED Controller

Error Codes

BASIC ERROR (MAJOR ERROR)	EXTENDED ERROR (MINOR ERROR)	DESCRIPTION
1	0	hardware error, transducer #1
2	0	hardware error, transducer #2
3	4	hardware error, transducer #3
4	0	hardware error, transducer #4
5	0	hardware error, transducer #5
6	0	hardware error, transducer #6
7	0	transducer #1 out of calibration
8	0	transducer #2 out of calibration
9	0	transducer #3 out of calibration
10	0	transducer #4 out of calibration
11	0	transducer #5 out of calibration
12	0	transducer #6 out of calibration
13	0	no transducer voltage
14	# of Points	not enough points taken for this command
15	0	points taken are too close together
16	0	temporary system not repeatable to 0.1"
17	0	no solution for system of points
18	0	error writing internal data -EEPROM not responding
19	0	zero or negative radius given - (1” ball calibration)
20	0	serial number mismatch -only a warning
21	0	serial number is zero / arm not calibrated -arm is unusable/inaccurate
22	0	controller box floating point math error
23	0	temperature deviation error - the temperature has changes more than 5° in the last 5 minutes
24	0	checksum error - might be reported while any type of file is sent, error receiving file
25	0	error writing FLASH - program unable to write FLASH - be FLASH not erased first/damaged
26	0	DMA or A/D error - either the DMA INT’s are not working, or the A/D INT’s are out
26	1	Capture line stuck high
26	2	Capture line stuck low
26	3	I2C error, buffer error
26	4	I2C error, CRC
26	5	I2C error, address
26	80	I2C error, T. case 1

BASIC ERROR (MAJOR ERROR)	EXTENDED ERROR (MINOR ERROR)	DESCRIPTION
26	82	I2C error, T. case 2
26	84	I2C error, T. case 3
26	86	I2C error, T. case 4
26	88	I2C error, T. case 5
26	90	I2C error, T. case 6 (only on 7 axis arms)
26	92	I2C error, T. case 6 or 7 (depending on 6 or 7 axis arm)
26	144	I2C error, temperature sensor
27	0	7 hardware error, transducer #
28	0	transducer #7 out of calibration
29	1	UART error, buffer error
29	2	UART error, not enough room to send

BASIC ERROR (MAJOR ERROR)	EXTENDED ERROR (MINOR ERROR)	DESCRIPTION
30	X	Renishaw bounced > 16ms, "X" is # of bounces
59	0	missing/invalid external data
60	0	error initializing serial port - will not report this over serial line.
61	0	error reading internal (EEPROM) data - invalid data in EEPROM
62	0	analog interface board initialization error

Troubleshooting

Error time-out on serial port

- Lost communication, check null modem cable
- Check A/C power
- Check host computer configuration input device

No serial communication from Controller Box

- Check cable
- Check baud rate

FARO provides CAM2 Caliper 3D for Windows, a simple utility program for the FaroArm. Starting CAM2 Caliper 3D confirms communication between the FaroArm and the host computer. To start CAM2 Caliper 3D, click the START menu and click the FARO CAM2 menu group. Click the CAM2 Caliper 3D icon in the menu group to start the program. This process confirms the connection of the FaroArm and the host computer. If communication is not established, the CAM2 Caliper 3D program dialogue box displays the following message: "*Cannot find a connected Arm.*" If the FaroArm connects using the CAM2 Caliper 3D program, the problem is in the configuration of FaroArm. If the FaroArm does not connect with the CAM2 Caliper 3D program, the problem is in the cabling or the host computer's communication port.

Single-point certification shows excessive error

- Must use ¼" probe
- Recalibrate tip
- During test watch the probe to ensure flush seating

Error indicator and flashing LED’s

- Refere to the LED error codes in your FaroArm User Manual.

Error message on host computer

- Refer to the LED error codes in your FaroArm User Manual.

Move Device Position out of tolerance

- Make sure that the distance between the points or target spheres on the move device position target are at least 11" apart.

Probe calibration fails

- Do probe calibration again, checking that all 27 points were taken.
- Make sure that probe tip is in contact with 1" ball.
- Be sure to exercise full sweep of arm and 1" ball during calibration.

Switches (front & back) will not respond

- Check LED’s on controller.
- Has arm traveled through all reference points?
- Turn auxiliary port OFF.

Too Fast

- Missed one point, slow scanning movement down.

Unable to establish coordinate system

- Make sure that distance between the origin, X-axis, and XY-plane points are at least 11" apart from each other.

Way too Fast

- Missed four points. Stream will be canceled.
- Stream rate is too dense, reset stream resolution.

Eulerian Angles

Eulerian Angles define an orthogonal coordinate system that results from three successive rotations from a fixed coordinate system.

The three successive rotations are:

A is a rotation about the Z-axis giving: X′,Y′,Z′ = **A**
B is a rotation about the X-axis giving: X′′,Y′′,Z′′ = **B**
C is a rotation about the Z-axis giving: X′′′,Y′′′,Z′′′= **C**

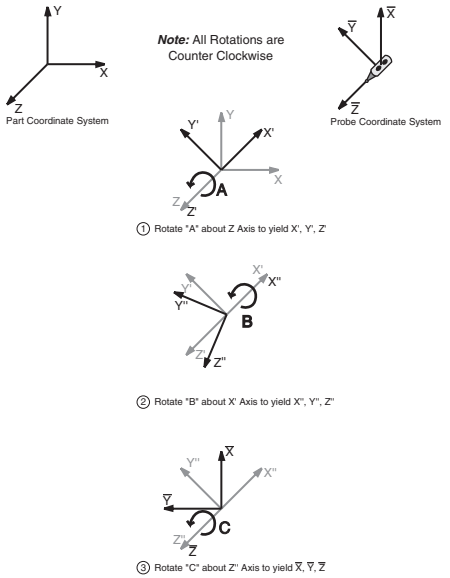


Figure 1-22 Eulerian Angles

Direction cosines I, J, and K can be computed from two of three Eulerian angles. The direction of these vectors are “in” to the part, or “out” of the FaroArm probe.

$$\mathbf{I} = (\sin B \sin A)$$

$$\mathbf{J} = (-\sin B \cos A)$$

$$\mathbf{K} = \cos B$$

Chapter 2: CAM2 Measure Devices Menu

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

Device Setup

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

When FaroArm starts the software attempts to initialize communication with the primary input device. A startup device cannot be saved in a settings file.

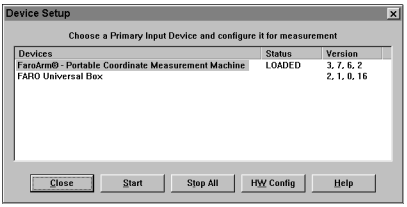
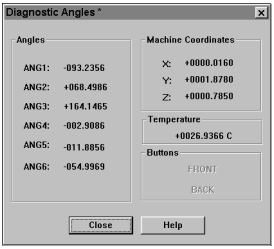


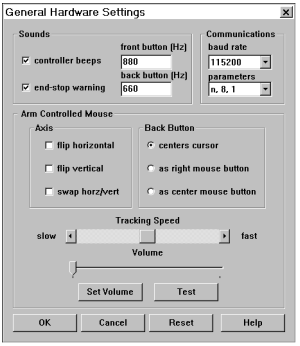
Figure 2-1 Device Setup Dialogue Box

Diagnostics

Select DEVICES < DIAGNOSTICS from the DEVICES menu. The DIAGNOSTIC ANGLES dialogue box displays encoder angles for each joint of the FaroArm, the FRONT and BACK button operations, X, Y, Z Machine Coordinates, and the Temperature of the devices internal sensor. Press the ESC key or click the CLOSE button to exit the command.



Hardware Configuration



Select DEVICES < HARDWARE CONFIG from the DEVICES menu. The communications, sound settings, and arm-controlled mouse settings for the measuring device and FaroArm are modified from the GENERAL HARDWARE SETTINGS dialogue box. Click OK to accept the changes. Click the CANCEL button to discard any changes and exit the command. The RESET button resets the Baud, Parity, Units, and Current Probe to factory settings.

FaroArm Default Settings:

Com Port	Baud	Parameter
COM1	9600	N, 8, 1

FaroArm recommended settings:

Com Port	Baud	Parameter
COM1	38400	N, 8, 1

Sounds: Turns the Control Box sound and end-stop warnings on or off and allows changes to button frequencies.

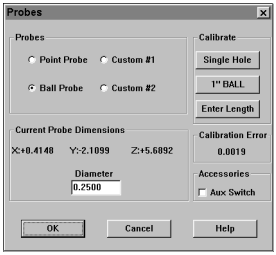
Arm-Controlled Mouse: The movement of the mouse cursor can be switched as it relates to the movement of the probe. These axis settings need to be switched only for an inverted FaroArm.

There are three options for the device's BACK button. These options are ignored during a measure command.

Tracking Speed: The speed of the cursor is adjusted using the Tracking Speed Slider.

Volume: The volume of the FaroArm internal speaker is adjusted by moving the slider to the left (low) and to the right (high). Click the SET VOLUME button to record the volume level. Click the TEST button to test the volume of the FaroArm's internal speaker.

Probes



Select DEVICES < PROBES from the DEVICES menu. In the PROBES dialogue box you can select the current probe, probe diameter, and calibrate the probe. The Auxiliary (Aux) switch activates the options port so you can use contact and touch trigger probes.

ENTER LENGTH is only used for sheath-type probes that slide over the ¼" ball probe. *See "Enter Tip Length" on page 47.*

The length is the distance between the end of the probe and the center of the ¼" ball over which it is mounted. This length is stamped on sheath-type probes fabricated by FARO. It is not necessary to enter the tip length for any ball or point tip probe.

> **NOTE**: You must select Custom #1 as the selected probe for this function to work.

Calibrate Tip

When changing the style or dimension of the probe at the end of the FaroArm, it must be calibrated for the FaroArm to measure and function accurately. The probe is calibrated through an optimization procedure that requires you to digitize points. Once selected, the new probe is assumed to be used in all subsequent measurements until a different probe is selected and calibrated. The two methods of calibration are the Single Hole and the 1" Ball.

Single Hole Method

The ¼" ball probe calibration is performed using a single 0.200" hole. The hole does not have to be exactly 0.200", but must be smaller than the probe's diameter with a smooth seat.

1 Digitize 10 points in the hole. Orientate the handle of the FaroArm in Position #1.

2 Digitize 10 more points in the hole. Orientate the handle of the FaroArm in Position #2.

NOTE: The rotation to Position #1 and Position #2 on 2-1-3 and 7-Axis Configurations is similar to the Calibration Positions figure.

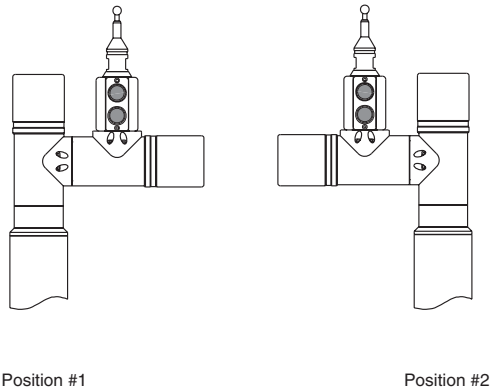


Figure 2-2 Calibration Positions

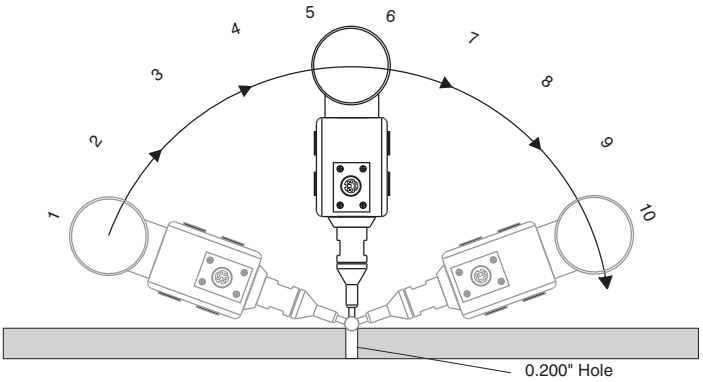
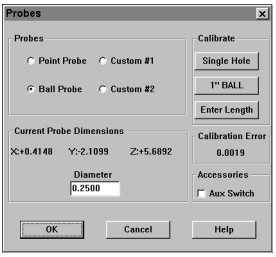


Figure 2-3 Single Hole Calibration

The calibration points are then calculated and the 2 Sigma results are displayed. The calibration error of the FaroArm should be below the stated single-point accuracy of 2 Sigma. The XYZ coordinates for the probe location are then displayed.



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

1" Sphere Configuration

1 Digitize five points around the circumference of the 1" sphere with the probe pointing toward the rear of the Arm. Orient the handle of the FaroArm into Position #1. (*See "Calibration Positions" on page 44.*)

2 Rotate the Arm 180° and digitize five additional points around the circumference of the 1" sphere. This is the FaroArm in Position #2. (*See "Calibration Positions" on page 44.*) Remember to point the probe toward the back of the Arm.

3 Digitize five points, east to west, across the sphere with the probe pointing toward the center of the 1" sphere. Orient the handle of the FaroArm into Position #2. Point the probe toward the center of the 1" Reference Sphere.

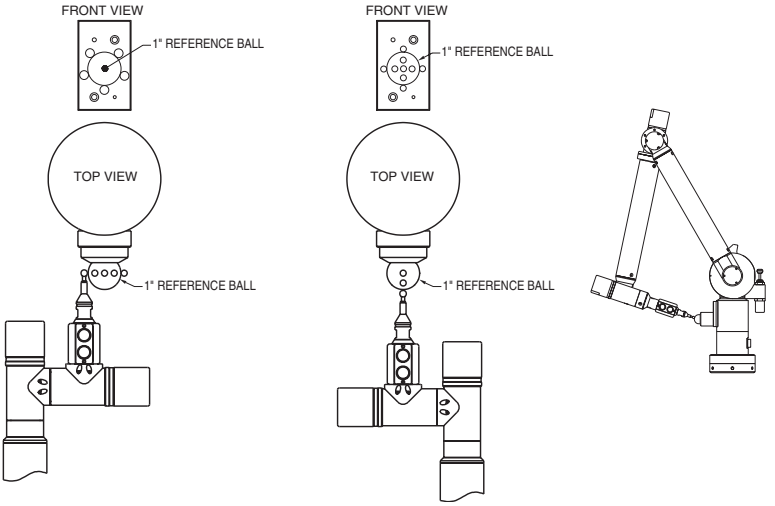


Figure 2-4 1" Reference Sphere Calibration

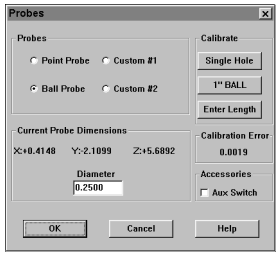
4 Rotate the handle of the FaroArm back to Position #1 and digitize four points, east to west, across the sphere. Again, point the probe toward the center of the 1" Reference Sphere.

5 Digitize four points, north to south, down the sphere with the probe pointing toward the center of the 1" sphere. Orient the

handle of the FaroArm in Position #1. Point the probe toward the center of the 1" Reference Sphere.

6 Rotate the handle of the FaroArm back to Position #2 and digitize four points, north to south, down the sphere. Again, point the probe toward the center of the 1" Reference Sphere.

The calibration points are then calculated and the 2 Sigma results are displayed. The calibration error of the FaroArm should be below the stated single-point accuracy of 2 Sigma. The XYZ coordinates for the probe location are then displayed.



NOTE: The probe must be in full contact with the reference sphere for all 27 calibration points digitized. Even one or two poorly digitized points significantly affects the optimization process, which then has an effect on the accuracy of the FaroArm.

Enter Tip Length

If you design a custom probe for the FaroArm, the accuracy of the measurement depends on the probe's design and the material used. If the tip is not a point or a ball, you *must* enter the length dimension of the new custom probe.

Enter the new length dimension of the custom probe. This length dimension is equal to the *difference* between the new custom probe and the length of the standard ¼" ball probe. First measure the ¼" ball probe length (base to center of ball), and then measure the length of the custom probe.

The length you want to enter is:

Custom Length - 1/4" Probe Length = New Custom Length

B - A = C

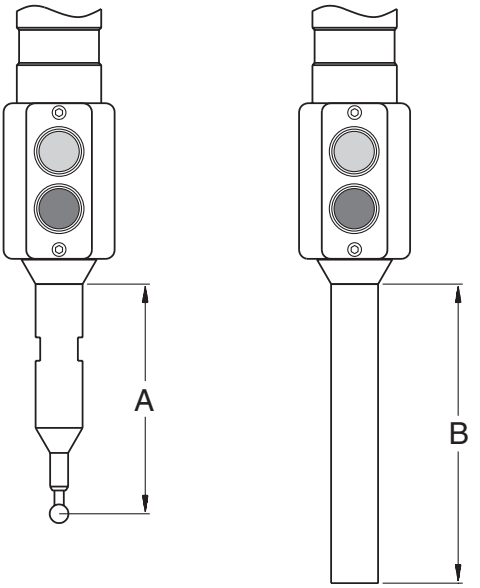
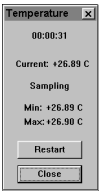


Figure 2-5 Custom Probe Length

Temperature



Select DEVICES < TEMPERATURE from the DEVICES menu. This command displays the current temperature of the FaroArm and the elapsed time of the temperature sampling. Device length corrections are made constantly. Because different components heat up or cool down at different rates, the device must be at a steady state temperature (within ±5° Celsius for five minutes) before measuring with the device.

Technical Support

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

- Be sure to read the relevant sections of the documentation. Many times the answer is right there.
- Visit the FARO Customer Service area on the Web at *www.faro.com* to search our technical support database. This is available 24 hours a day 7 days a week. Have your FaroArm Serial Number and FARO Customer Order Number available before connecting to the site.
- 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. Use the worksheet in Appendix A as a guide.
- If you still cannot resolve your problem, have your FaroArm Serial Number available *before calling*.

You can contact our Technical Support Team directly if you are eligible under the FARO Service Policy (see Appendix A). Technical Support hours are from 8:00 a.m. to 5:00 p.m. Eastern Standard Time (EST), Monday through Friday. You can also fax in your problems or questions 24 hours a day.

ALL USERS

- FAX SUPPORT (407) 333-8056
- E-mail support@faro.com

Faxes sent outside regular working hours (8:00 a.m. to 5:00 p.m. EST, Monday through Friday) usually are answered before 12:00 p.m. EST the next working day. Please be sure to use the **Customer Service**

Industrial Fax Form located in Appendix A of this manual. Include your return fax and telephone numbers and the name of the certified user.

CERTIFIED USERS

- TELEPHONE SUPPORT (800) 736-2771 U.S. / (407) 333-3182

Technical Support hours are 8:00 a.m. to 5:00 p.m. EST, Monday through Friday. Should our staff be on other calls, please leave a voice mail message; calls are always returned within 4 hours. Please remember to leave a detailed description of your question and your FaroArm 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 "Licenser") By your use of the software you are agreeing to the terms and conditions of this Software License Agreement. Throughout this Software License Agreement, the term "Licensee" means the owner of the System.

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

II. The Licenser 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-Licenser 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 Licenser'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 Warranty Appendix B pursuant to which the Software was purchased from the Licenser.

V. THIS WARRANTY IS IN LIEU OF OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE SOFTWARE AND WRITTEN MATERIALS. IN NO EVENT WILL THE LICENSER BE LIABLE FOR DAMAGES, INCLUDING ANY LOST PROFITS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE SOFTWARE, NOTWITHSTANDING THAT THE LICENSER HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, THE LICENSER WILL NOT BE LIABLE FOR ANY SUCH CLAIM BY ANY OTHER PARTY.

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

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

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

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

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

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

Appendix B: Purchase Conditions

All Purchase Orders (hereafter, the "Order") for FARO-provided products and services (hereafter, the "Product") are subject to the following terms and conditions, which are agreed to by the Purchaser. All capitalized terms are defined in Section 9 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 5 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 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 majuere, 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 maintanence/ warranty service is set forth in Appendix A.

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 maintanence/warranties set out in paragraphs 4.01 and 4.02 above (together called the "Maintanence/Warranties") shall expire at the end of the twelve (12) month period commencing on the first day of the first quarter after the date of shipment from the FARO factory (the "Maintanence/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 or the Software and reported to FARO within the Maintanence/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 or the Software 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, Software 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, or the Software. Within a reasonable time of receipt of such notice, FARO shall have the System, FaroArm and Software diagnosed by its service personnel and maintanence/warranty service will be provided at no cost to the Purchaser if the System, FaroArm or Software 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, the FaroArm and Software are not defective, the Purchaser shall pay the cost of service, which shall be the amount that FARO would otherwise charge for an evaluation under a non-warranty service evaluation.

4.06 The Warranties do not apply to:

a) Any defects in any component of a System where, if in the reasonable opinion of FARO, the FaroArm, Software or System has been improperly stored, installed, operated, or maintained, or if Purchaser has permitted unauthorized modifications, additions, adjustments and/or repair to any hard drive structure or content, or any other part of the System, or which might affect the System, or defects caused or repairs required as a result of causes external to FARO workmanship or the materials used by FARO. As used herein, "unauthorized" means that which has not been approved and permitted by FARO.

b) The Warranties shall not cover replacement of expendable items, including, but not limited to, fuses, diskettes, printer paper, printer

ink, printing heads, disk cleaning materials, or similar items.

c) The Warranties shall not cover minor preventive and corrective maintenance , including, but not limited to, replacement of fuses, disk drive head cleaning, fan filter cleaning and system clock battery replacement.

d) Any equipment or its components which was sold or transferred to any party other than the original Purchaser without the expressed written consent of FARO.

4.07 Factory Repairs

a) IF SYSTEM IS UNDER MAINTANENCE/WARRANTY: The Purchaser agrees to ship the Product to FARO in the original packing containers. FARO will return the repaired or replacement Product. FARO will incur the expense of the needed part and all return shipping charges to the Purchaser. FARO may authorize the manufacturer of a component of the Product to perform the service.

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

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

4.08 Nothing herein contained shall be construed as obligating FARO to make service, parts, or repairs for any product available after the expiration of the Maintanence/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 Maintanence/Warranties extend only to the Purchaser and are transferable, only under the following conditions:

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

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

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

4.14 PURCHASER ACKNOWLEDGES THAT IT HAS PURCHASED THE SYSTEM BASED UPON ITS OWN KNOWLEDGE OF THE USES TO WHICH THE SYSTEM WILL BE PUT. FARO SPECIFICALLY DISCLAIMS ANY WARRANTY OR LIABILITY RELATED TO THE FITNESS OF THE SYSTEM FOR ANY PARTICULAR PURPOSE OR ARISING FROM THE INABILITY OF THE PURCHASER TO USE THE SYSTEM FOR ANY PARTICULAR PURPOSE.

5.00 Design Changes

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

6.00 Non-Disclosure

6.01 All Software including, without limitation, the Operating System Program and any FARO special user programs, provided to the Purchaser as part of the system, either at the time of or subsequent to the

delivery of the FaroArm, is the intellectual property of FARO. The Purchaser shall not reproduce or duplicate, disassemble, decompile, reverse engineer, sell, transfer or assign, in any manner the Software or permit access to or use thereof by any third party. The Purchaser shall forthwith execute any further assurances in the form of non-disclosure or licensing agreements which may reasonably be required by FARO in connection with the software.

7.00 Entire Agreement / Governing Law / Miscellaneous / Guarantee

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

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

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

7.04 FARO shall be entitled to recover all of its reasonable fees and costs including, but not limited to, its reasonable attorneys' 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 diskettes 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 associated with the FaroArm.

8.06 “Certified user” means any person who has completed and passed the a 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 “Maintanence/Warranty Transfer Form” means a document to be completed for the transfer of the FARO Maintanence/Warranty. This document is available from FARO upon request.

Appendix C: Industrial Products Service Policy

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

FARO Hardware under Maintanence/ Warranty

The following is a summary of what services can be obtained under the Standard maintanence/warranty.

1 Factory repairs on FARO manufactured hardware product defects (see attached Customer Service Fax Form for troubleshooting).

2 Factory repairs are usually completed within 7 working days of FARO's receipt of the defective item. The customer is responsible for returning the hardware to FARO in the original packing container or custom case.

3 FARO will return the hardware via 2-day air service to the Continental U.S. Outside the Continental U.S., FARO will return the hardware to the customs broker via 2-day air service. Expedited service can be arranged at the customer's expense if the customer's corporate account number is provided.

4 Free telephone support for technical problems and applications, for all certified users. For every FaroArm or training purchased free certification is provided. (See the *Certification Requirements*section.)

5 Maintanence/Warranties can be renewed annually on FARO-manufactured hardware products.

6 A maintanence/warranty **cannot** be purchased if the original or renewed maintanence/warranty has expired.

7 All maintanence/warranties will be due for renewal in one of the following quarterly months: March, June, September or December. The quarterly month after the ship date month will be the month the maintanence/warranty expires. Example: The hardware was shipped on January 10, 1996, therefore, the renewal will be due by March 31, 1997.

8 Maintanence/Warranties are transferable to subsequent owners under certain conditions:

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

9 Free Caliper 3D upgrades.

FARO Hardware NOT under Maintanence/ Warranty

CAM2 Caliper 3D software updates must be purchased for the current published list price.

Telephone support will cost $2.00 per minute, or the customer may use the Customer Service Fax Form (sample attached) for troubleshooting problems via fax at no charge.

If the initial troubleshooting does not resolve the problem, then all factory assessments and repairs on FARO-manufactured products will follow the following procedure:

1 The customer obtains a service number from FARO's Customer Service Department.

2 The customer sends the part to FARO with the service number on the label along with $1,500 payment or a corporate purchase order for system testing and evaluation, which includes calibration and recertification.

3 The payment will be applied toward the total service cost beyond the initial payment. The estimate repair cost will be

given to the customer prior to the repair. The total cost must be paid prior to beginning the service.

4 System testing and evaluation can take up to 30 days. FARO-manufactured part repairs can take up to 60 days. However, the part will be scheduled for service as soon as it arrives at FARO's factory.

5 FARO will return the repaired part via UPS ground service in the USA only. If the customer is outside the continental U.S., FARO will return the repaired part via UPS ground service directly to the customs broker. Expedited service can be arranged at the customer's expense if the customer's corporate account number is provided.

FARO Software under Maintanence/ Warranty

A one-year maintanence/warranty comes with the purchase of all new FARO-developed software. The maintanence/warranty includes:

1 Free telephone and fax support for all certified users (see certification section).

2 Free updates and new releases of FARO-developed software.

- Maintanence/Warranties can be renewed annually for FARO-developed software.

- All maintanence/warranties will be due for renewal in one of the following quarterly months: March, June, September or December. The quarterly month after the purchase month will be the month the maintanence/ warranty expires. Example: The software purchase was made in January 10, 1996, the renewal will be due by on March 31, 1996.

FARO Software NOT under Maintanence/ Warranty

Once the maintanence/warranty has lapsed on FARO software, the following applies:

1 Telephone support will cost $2.00 per minute.

2 Questions may be faxed to FARO's Customer Service department at no charge. Please use the Fax Form attached.

3 Once out of maintanence/warranty, the customer may elect to purchase the current software upgrade at 50% of the current list price. Maintanence/warranty renewals for subsequent years will be available at the current published maintanence/ warranty renewal rate.

Hardware & Software Training

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

1 The training class will prepare attendees to successfully attain an operators certification (see *Certification Requirements* section for more details).

2 The fee schedules for advanced additional training courses can be obtained from Customer Service, or the Industrial Training Department.

Certification Requirements

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

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

1 Attend a FARO-conducted basic training course, either at a FARO Facility or on site at your facility.

2 Certification will be awarded once the class has been completed, and then the certified user will be registered for hardware and software support.

To certify an operator, call FARO Technologies Inc. Training Department, 800.736.0234 (North America), 407.333.9911 (Worldwide), for updated information.

FaroArm Repair Fee Schedule

(Out of Maintanence/Warranty Owners Only!)

System Testing and Evaluation Fee

A fee is charged for any system testing and evaluation. This includes system diagnosis, calibration and/or recertification, and applies to all FaroArm's. However, this fee does not include disassembly/repair costs if required. An estimated cost for disassembly/repair will be given to the customer prior to the repair. The disassembly/repair charges must be paid in full prior to the actual disassembly/repair. However, if no repairs are needed the fee will be applied to the cost of system testing and evaluation. All evaluations contain a recertification. Re-certification will be performed on an "as needed" basis.

$ 1,500.00

Repair Times

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

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

*Includes Calibration and Recertification

125 Technology Park, Lake Mary, FL 32746
Customer Service Industrial Fax Form
From: User Name:_____

Certified?_____ **Yes** _____**No**

Certification Number:_____

FaroArm Serial Number:_____
(Serial number is located on the FaroArm or your certified user card)

Return Fax Number:_____

Return Voice Number:_____

Problem:

Where & when does it occur?

What have you done to fix the problem?

FAX to: (407) 333-8056

Transfer of Maintanence/Warranty Service Plan Agreement

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

hereby waives all rights under the warranty service policy for

FaroArm Serial Number_____

CAM2 Port Lock Number _____

purchased originally on _____(DATE).

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

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

This transfer is only valid under the following conditions.

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

AGREED

_____	_____
(PRINT SELLER'S CORPORATE OR INDIVIDUAL NAME AS APPLICABLE),	(PRINT SELLER'S CORPORATE OR INDIVIDUAL NAME AS APPLICABLE),
BY x _____	BY x_ _____
_____	_____
(PRINT NAME OF SIGNATORY)	(PRINT NAME OF SIGNATORY)

FARO Technologies Inc.

Approved by x _____

_____
(PRINT NAME OF SIGNATORY)

Appendix D: Industrial Service Policy

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

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

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

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

1.03 The plan shall consist of two areas of coverage:

a) Hardware - The FaroArm and all of the associated optional parts, and the Computer if provided by FARO.

b) Software - All computer programs, authored by FARO, which are used in conjunction with the FARO provided Hardware.

1.04 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.

1.05 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.

1.06 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.

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

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

b) Software - All computer programs, authored by FARO, which are used in conjunction with the FARO provided Hardware, will be updated if the Plan is current.

c) 3rd Party Software - All computer programs, non 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.

2.00 Definitions

2.01 "FARO" means FARO Technologies, Inc.

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

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

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

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

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

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

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

Standard Service Plans

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

- Basic Service Plans are contracted at time of purchase or at any time while a unit is covered by a FARO hardware and FARO software service plan (as described in more detail later).
- The Basic Service Plan covers all of the major components of the Turnkey System sold by FARO. This typically covers the FaroArm controller box, the FARO-provided computer, and FARO authored software.
- Shipping costs, including insurance from the Purchaser to FARO are the responsibility of the Purchaser. FARO will be responsible for all return shipping costs including insurance.
- All reasonable efforts will be made to keep the service repair time within seven working days. The equipment will be returned via 2-Day air service, therefore, total service repair time will vary due to return shipping location.
- The Standard Service Plan is offered as a package only and cannot be broken into separate components. Separate component coverage is available through purchase of FARO's standard maintanence/warranty programs (See Purchase Conditions).
- Since the FaroArm is designed to be used with many other software packages not authored by FARO. This service plan can be purchased in its entirety to cover only FARO produced or authored products. For items not produced or authored by FARO, the customer is responsible for securing their own separate warranty or service plan coverage.

Hardware Coverage

FaroArm

Covered

- All parts and labor for FaroArms failing under normal use as described in Appendix B.
- Annual recertification and 15-point annual checkup of the FaroArm.

Not Covered

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

Computer

Covered

- Faro contracts with 3rd party service providers for this service. The terms and conditions of FARO's contract with the provider apply herein and are incorporated herein by reference. Ask your Customer Service Rep for a copy of this document.
- Typically, these services include repair of the computer, memory cards, and video monitors.

Not Covered

- All exclusions contained in the 3rd party service providers policy which is incorporated herein by reference.
- Software operating system installation.
- User intentional or unintentional removal of key software property or files.

Software Coverage

Covered

- Periodically, FARO Technologies may update its proprietary software. Service plan subscribers will be shipped these software updates upon their release.

Not Covered

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

Premium Service Plans

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

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