

**MINUTEMAN  
3D TRACKER  
USER MANUAL**

URM06PH191  
REV. A – FEBRUARY 2008

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Colchester, Vermont, U.S.A.

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## **FCC Statement**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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

## **EC – Declaration of Incorporation**

**This Product Complies with the following European Community Directives:**

89/336/EEC as amended by 92/31/EEC

**The following standards were used to verify compliance with the directives:**

### **EMC:**

EN 61326-1:1997 / A1:1998 / A2:2001 / A3:2003 Emissions Requirements Class B, Radiated Emissions

EN 61326-1:1997 / A1:1998 / A2:2001 / A3:2003 Immunity Requirements

EN 61000-4-2:1995 (ESD 4kV CD, 8kV AD)

EN 61000-4-3:2002 / A1:2002 (3V/m 80% AM)

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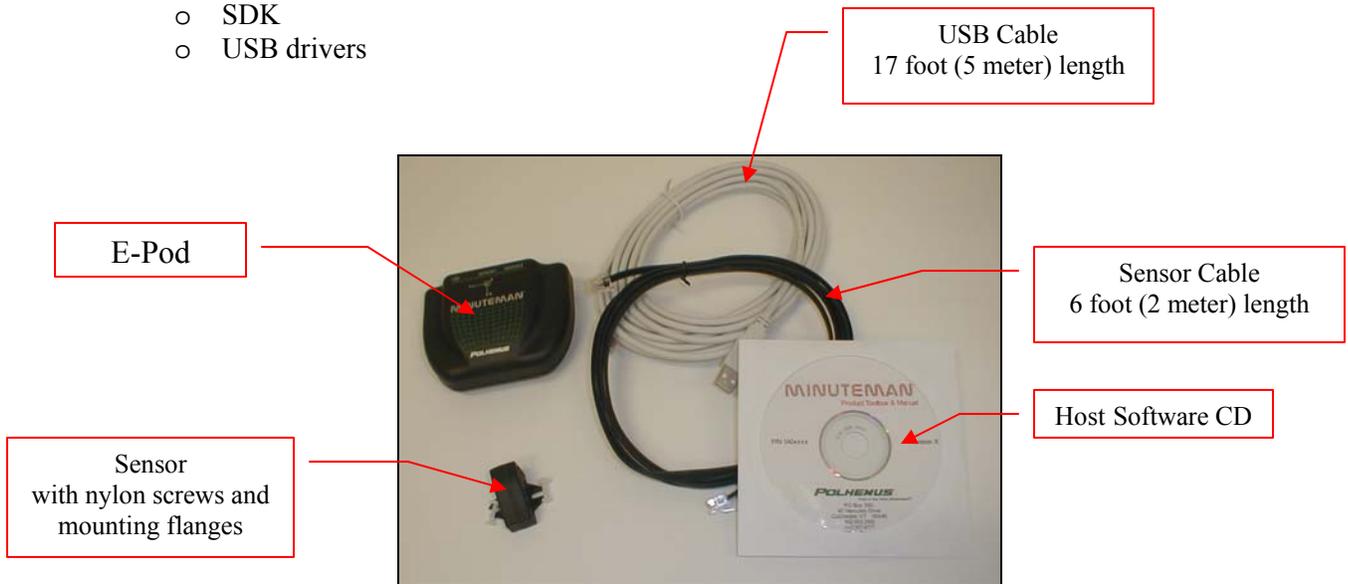
## Welcome

Thank you for purchasing the highest performance, lowest cost, best value tracker on the planet! The following will acquaint you with the components of the system, how to connect it, and how to set it up for your application.

## Components

The following components (see [Figure 1](#)) make up a MINUTEMAN system.

- MINUTEMAN E-Pod
- Sensor with two nylon mounting screws
- 6 foot (2 meter) sensor cable with 6 pin modular connectors
- 17 foot (5 meter) USB cable
- MINUTEMAN Host Software CD containing:
  - o This manual
  - o PiMgr graphical user interface
  - o SDK
  - o USB drivers



**Figure 1 MINUTEMAN Components**

## Initial MINUTEMAN Setup and System Test

Follow these set-up and connection steps to demonstrate basic operation of your MINUTEMAN system.



Caution: Do not connect the USB cable until instructed.

### 1. *Install the MINUTEMAN Host Software.*

- i. Insert the MINUTEMAN Host Software CD into your computer's CD-ROM drive. If your system is configured for CD auto-launch, the MINUTEMAN Host Software installation panel will launch automatically. If it does not, launch the panel manually by navigating to the CD-ROM drive using Windows Explorer. Run "Setup.exe".
- ii. Click on the area labeled "Install Host Software." The installation wizard will walk you through the installation.
- iii. Leave the CD in the CD-ROM drive for USB device installation.



NOTE: The MINUTEMAN Host Software is intended to be installed on a computer running Windows® XP, 2000 and Vista only.

### 2. *Connect sensors to the MINUTEMAN E-Pod.*

One or more sensors must be connected to the MINUTEMAN E-Pod (see [Figure 2](#)) *prior to* connecting the USB cable. Connect sensor(s) with the six-pin modular connectors on the black 2 M cable.



Figure 2 MINUTEMAN E-Pod



NOTE: The six-pin modular sensor cable is readily available in the marketplace should more length be required. However, a substitute sensor cable must not exceed 14 ft (4.25 m) and must be wired *straight through* both connectors, male-male.

### 3. Connect MINUTEMAN E-Pod to Host USB.



NOTE: MINUTEMAN gets its operating power through the USB connection. If you are using a USB hub that does not provide the full USB power allotment, the E-Pod will not operate!

When the USB cable is connected to the host PC for the first time, Windows will detect the new hardware and launch the device driver installation wizard. The MINUTEMAN driver installation is slightly more complex than most USB devices because the drivers are installed in two steps:

- i. First Windows will detect and install the MINUTEMAN drivers. The “Found New Hardware” bubble will appear in the Windows taskbar:



Windows will automatically launch the Found New Hardware Wizard (see [Figure 3](#)), which will walk you through the driver installation procedure. If your MINUTEMAN Host Software CD is not in the CD-ROM drive, insert it now. Select “Install the software automatically” and click “Next”:



**Figure 3** “Found New Hardware” Screen

Click on the “Finish” button when the driver installation is complete.

- ii. Next, Windows will detect the USB-Serial Port emulation device:



Again, the Found New Hardware Wizard will launch automatically. Leave the CD in the CD-ROM drive, select “Install the software automatically” (see [Figure 4](#)) and click “Next”:



**Figure 4** USB Serial Port “Found New Hardware” Screen

At this phase of the driver installation, Windows XP may warn you that the driver being installed “Has not passed Windows Logo testing,” or is a digitally unsigned driver. Click “Continue Anyway” to proceed with the installation.

Click on the “Finish” button when the driver installation is complete.



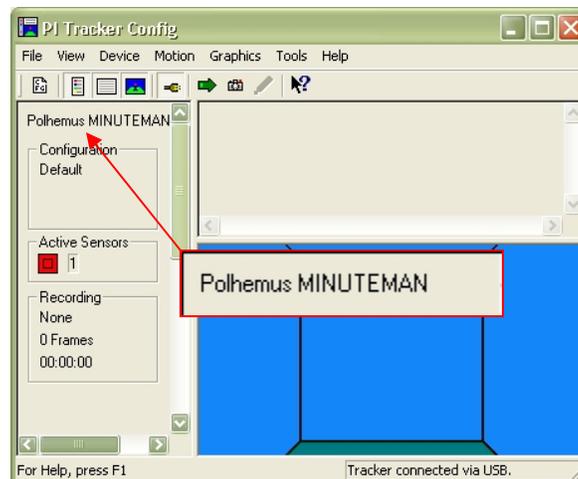
NOTE: The “unsigned driver” warning indicates that the driver has not been submitted to Microsoft’s “Designed for Microsoft Windows XP” logo testing program. It does **not** mean that the driver is incompatible with Windows XP. This driver has been thoroughly tested and approved by Polhemus Quality Assurance.

#### **4. Verify MINUTEMAN Hardware.**

When the E-Pod receives power from the USB connection, note that the red power LED indicator is illuminated. It blinks three times during initialization and then stays illuminated. To verify this, disconnect and then reconnect the USB connector now.

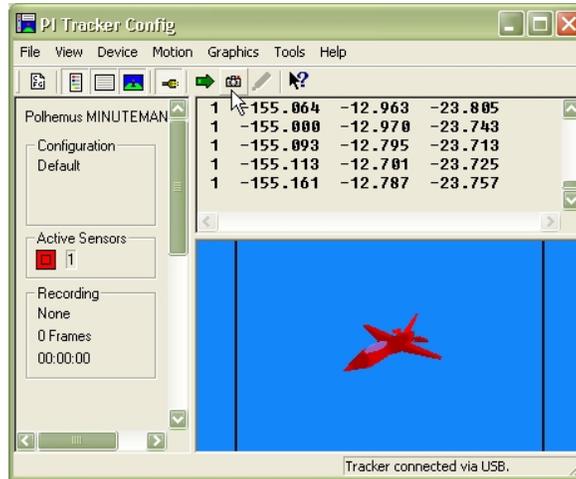
#### **5. Verify MINUTEMAN Function and Host Software.**

- i. With the MINUTEMAN still connected via USB, launch the PiMgr tracker management application from the Windows desktop shortcut .
- ii. With the MINUTEMAN already attached via USB, PiMgr will automatically discover it (see [Figure 5](#)) and query its configuration:



**Figure 5** PI Tracker Config Screen

- iii. Collect MINUTEMAN sensor orientation data (see [Figure 6](#)) by clicking on the single frame toolbar button . Note the orientation of the sensor displayed by PiMgr:



**Figure 6** Sensor Orientation Data Collection Screen

- iv. Initiate continuous data collection by clicking on the continuous mode toolbar button . Move the sensor to note that orientation data changes as expected. Click  again to suspend continuous data collection.



**NOTE:** For detailed instruction on the use of the PiMgr, refer to the PiMgr online help, accessible by pressing F1 anywhere on the PiMgr window.

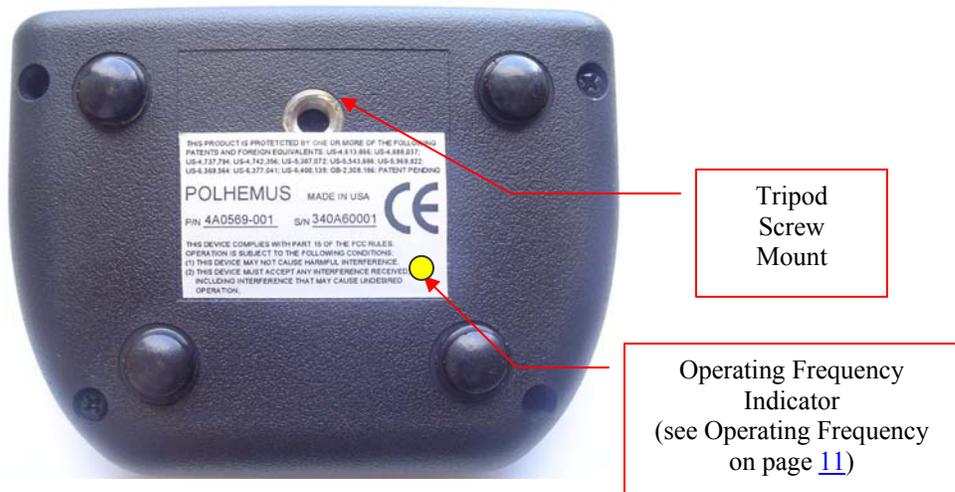
## Operational Installation

### Location and Mounting

Set up MINUTEMAN close to your host computer and away from large metal objects like file cabinets, metal desks, etc., and away from the floor and walls. Also, it is important to position the system so that the working area for your application is centered in the 36 inch/90 cm radial range of the MINUTEMAN. A standard tripod screw mount (see [Figure 7](#)) is provided on the underside of the E-Pod. Polhemus recommends the use of a non-metal tripod mount (see [Figure 8](#)).



**CAUTION:** To avoid damage to the electronics, do not force the tripod screw after it has been firmly seated in the mount.

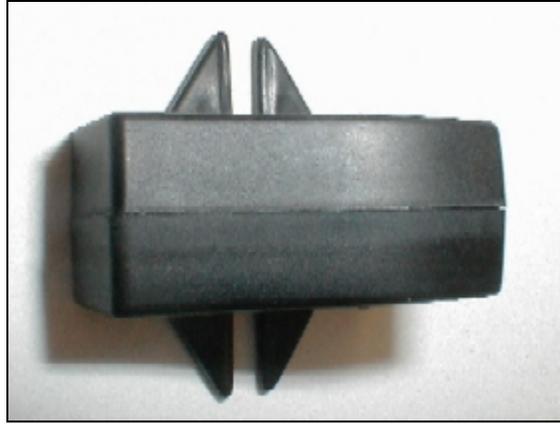


**Figure 7** E-Pod screw mount



**Figure 8** E-Pod mounted on tripod

MINUTEMAN sensors can be screwed down with the provided nylon screws through slots in the sensor mounting flanges (see [Figure 9](#)). The slotted flanges allow sensors to be installed into pre-existing fixtures. If a smaller footprint is needed, the mounting flanges can be clipped off and the sensor can be mounted with adhesive.



**Figure 9** Sensor Mounting Flanges



NOTE: Nylon hardware is only required when the hardware will be **in direct contact with the E-Pod or sensor**. A testing surface where the devices will be used (a table, for example, could have small metal hardware like screws, nuts, and bolts, which probably would not affect the accuracy of the MINUTEMAN..

## Coordinate Reference

Reference diagrams are printed on the top of the E-Pod (see [Figure 10](#)) and on the sides of the sensor (see [Figure 11](#)). MINUTEMAN orientation tracking occurs according to the “right-hand” rule (see [Figure 12](#)) with reference to these markings. To demonstrate the “right-hand” rule point the index finger of your right hand along the desired reference frame Y-axis with your palm facing the Z-axis; your thumb will point to the X-axis

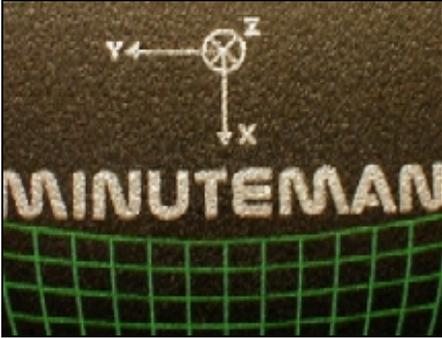


Figure 10 E-Pod Reference Diagram



Figure 11 Sensor Reference Diagram

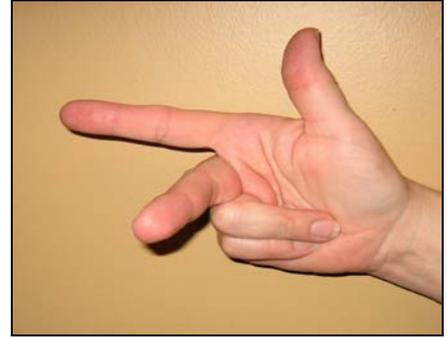
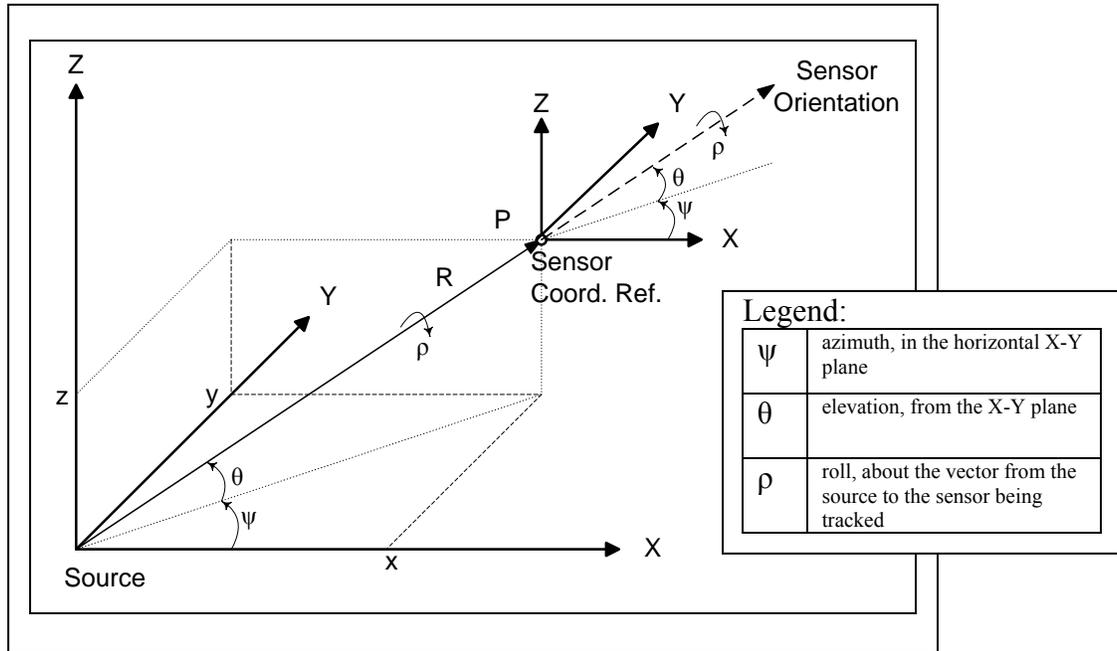


Figure 12 “Right-Hand” Rule

The sensor’s Azimuth, Elevation, and Roll (AER) angles are based on this orientation. Both the sensor and the E-Pod (source) have these orientation coordinates. By default, the E-Pod is the reference, with an orientation of (0, 0, 0) AER. The measured AER of each sensor is relative to the E-Pod. In a typical installation, the E-Pod is installed in alignment with the natural coordinates of the environment (see [Figure 13](#)), and the sensors are then referenced to those coordinates.



NOTE: **Euler angles** Azimuth, Elevation, and Roll (AER), are also known as “Yaw,” “Pitch” and “Roll.” This is the default form in which MINUTEMAN reports sensor orientation. See the section entitled “Output Orientation Format” for more information.



**Figure 13** Coordinate Reference System

Should you wish to start your application at a (0,0,0) AER orientation, the sensor should be brought in line with the E-Pod X-axis indicated (see [Figure 14](#)) and then rotated to achieve approximately that orientation. MINUTEMAN components should be mounted to fix this mechanical alignment.



**Figure 14** Sensor Aligned with E-Pod

Refer to [Boresight](#) on page [14](#) for details on setting the relative AER to (0,0,0).

## Multiple MINUTEMAN Systems Installation

Wherever multiple MINUTEMAN E-Pods are to be employed it is important to note the following:

### 1. Operating Frequency

Four different operating frequencies allow up to four E-Pods to operate in the same environment without interfering with each other. The operating frequency of each MINUTEMAN is denoted by a colored dot on the E-Pod (see [Figure 7](#)). The colors and frequencies are:

<b>30 KHz – Yellow (Standard)</b>
<b>33 KHz – Black</b>
<b>28.5 KHz – Red</b>
<b>31.5 KHz - Blue</b>



**CAUTION:** If multiple E-Pods are to be used together, care must be taken to ensure that when ordering the second, third and fourth MINUTEMAN E-Pods, each operates at a different frequency.

### 2. USB Power

Use the native USB port or a powered hub to operate the MINUTEMAN E-Pod. A USB expansion hub typically does not provide such power.

### 3. Coordinate System

In most multi-E-Pod environments, all E-Pods will be aligned to the same coordinate system.

To accomplish this, E-Pods could be placed side-by-side on a tripod extension bar and pointed in the same direction. Sensor mountings for each E-Pod system should also be identical to achieve the same orientation reference. Each E-Pod defines the reference system for the sensor(s) connected to it. If multiple E-Pods are in use, be aware of the possible need to harmonize or align the E-Pod reference frames, either mechanically or mathematically.



**NOTE:** When mounting E-Pods side-by-side, keep them spaced at least 6 inches (16 cm) apart.

## MINUTEMAN Configuration

MINUTEMAN has a simplified command structure with a small set of commands to control and to configure the E-Pod. Commands include output orientation data format, filtering, boresight, and soft reset. MINUTEMAN can be managed entirely through the PiMgr tracker management application that is included on the MINUTEMAN Host Software CD. For custom applications, MINUTEMAN can be driven with the Polhemus Developer Interface SDK, also included on the CD.



NOTE: MINUTEMAN configuration settings do not persist through any soft- or hard- reset of the E-Pod. Settings must be re-applied each time MINUTEMAN is reset.

### ***Output Orientation Format***

MINUTEMAN can be configured to output orientation data in three different formats:

- **Euler Angles (default)**

Euler angles define the current orientation of the sensor coordinate frame with respect to the designated reference frame, commonly known as Azimuth, Elevation, and Roll (AER), or in the aerospace context, Yaw, Pitch and Roll. Euler angles are expressed as floating-point numbers.

They refer to the three angles used to describe a general rotation in three-dimensional Euclidean space by three successive rotations, once about the  $z$ -axis (Azimuth/Yaw), once about the  $y$ -axis (Elevation/Pitch), and once about the  $x$ -axis (Roll).

- **Direction Cosines**

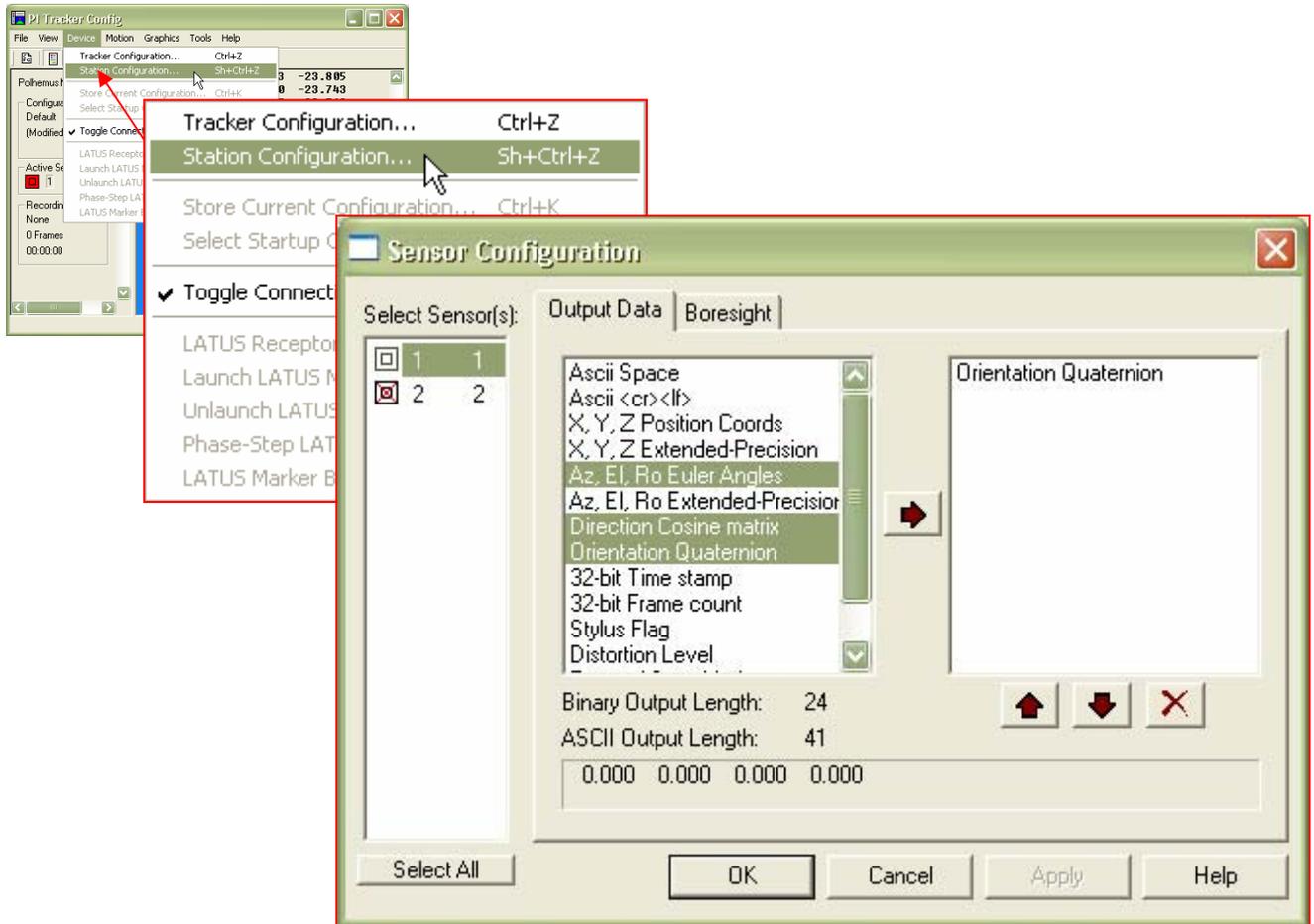
Direction cosines are a 3x3 floating-point matrix representing the cosines of the angles between the sensor's  $x$ -,  $y$ -,  $z$ -axes and the  $X$ -,  $Y$ -,  $Z$ -axes of the reference (E-Pod or source) frame.

- **Orientation Quaternion**

A quaternion is an ordered four-parameter quantity of floating-point numbers representing a vector and a scalar. The first coordinate is the 'scalar' part, and the remaining three make up the 'vector' part. Quaternions are often used in computer graphics and associated geometric analysis to represent rotations and orientations of objects in three-dimensional space. They are smaller than other representations, and operations on them can be computed more efficiently. Quaternion algebra is also more numerically stable for this purpose (see below).

Euler angles are the most straightforward method of expressing orientation. However, at high elevation, calculated Euler angles are subject to “gimbal lock.” That is, as elevation approaches +90° or -90°, the axes about which azimuth and roll are computed become a single axis and the third angle of rotation describing the orientation is lost. Direction cosines and quaternions are provided to overcome this problem. Although direction cosines and quaternions are more mathematically complex, they are not subject to these axis singularities.

Output orientation format is configured per sensor in the “Sensor Configuration” dialog (see [Figure 15](#)) of the PiMgr  tracker management application:



**Figure 15** Configure Output Orientation Format

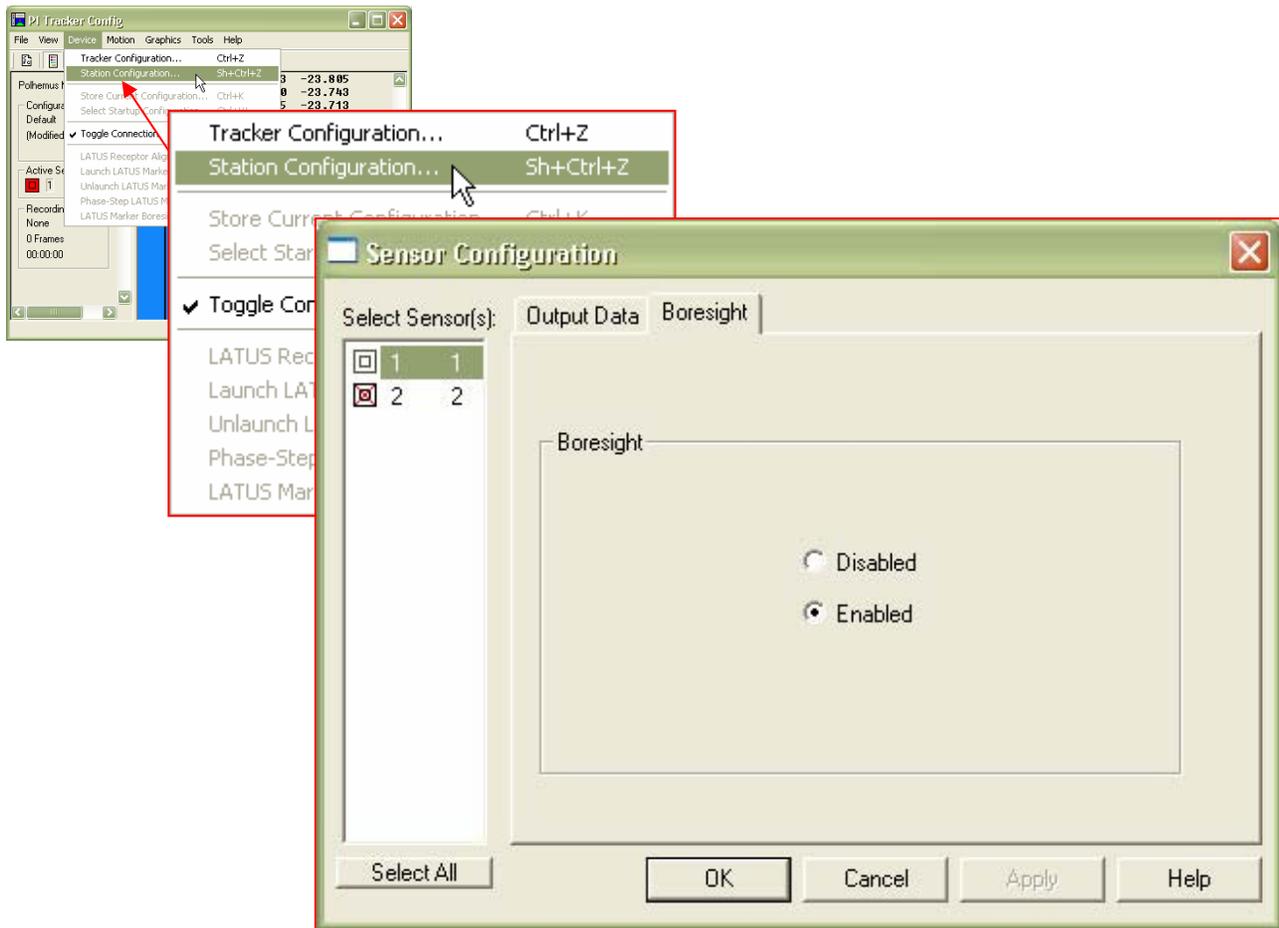


**NOTE:** For detailed instruction on the use of the PiMgr, refer to the PiMgr online help, accessible by pressing F1 anywhere on the PiMgr window.

## Boresight

MINUTEMAN can be instructed to enable or disable boresight rotation of individual sensors at any time. When instructed to enable boresight, the orientation of the sensor is rotated so as to align the sensor with the E-Pod reference frame of AER (0,0,0). The orientation received from the affected sensor will be effectively reset to AER (0,0,0), regardless of its actual physical orientation.

By default, MINUTEMAN boresight is disabled. Boresight is applied per sensor in the “Sensor Configuration” dialog (see [Figure 16](#)) of the PiMgr  tracker management application:

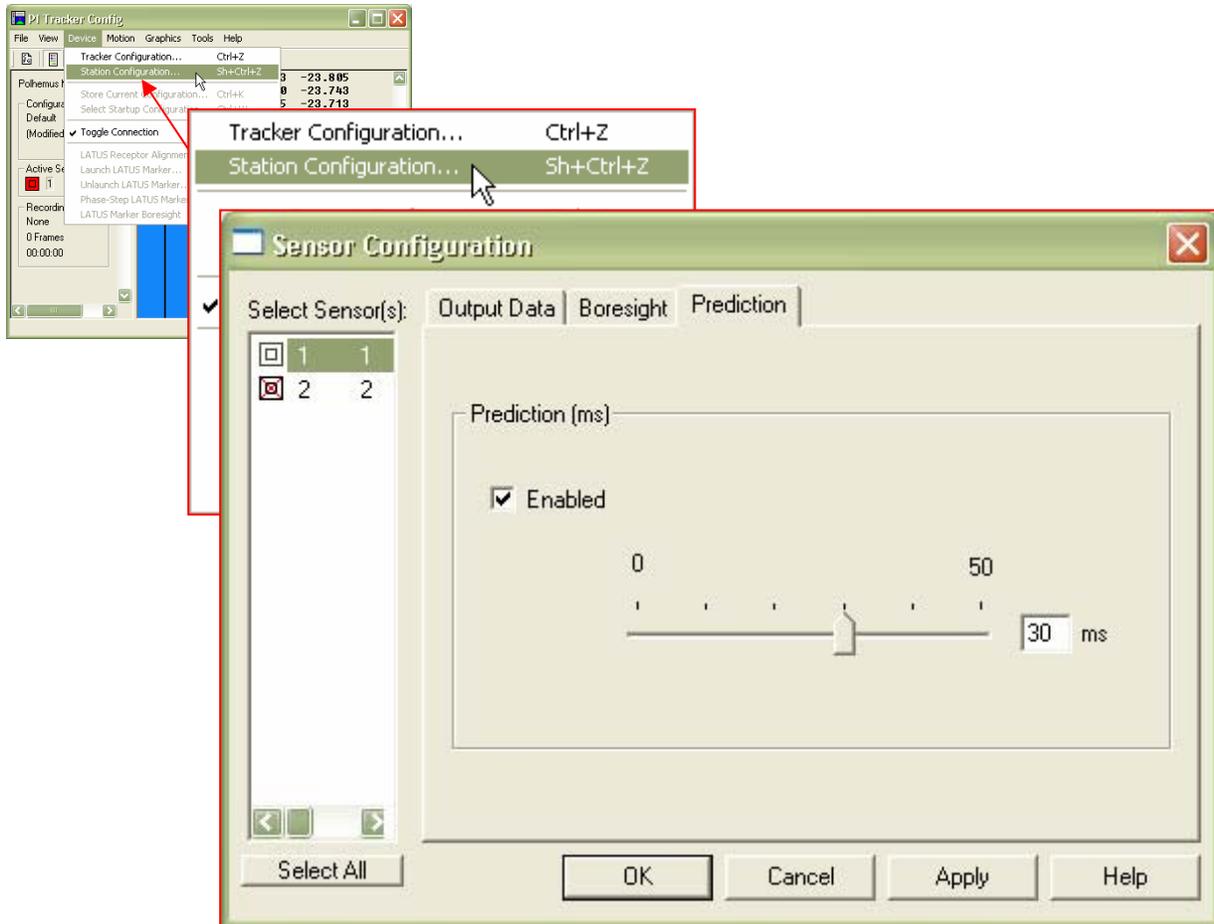


**Figure 16** Configure Sensor Boresight

## Host Prediction

Prediction up to 50 ms can be enabled for each MINUTEMAN sensor. The prediction operation is performed on the host, not the MINUTEMAN device. This operation requires that the configured [Output Orientation Format](#) (see page 12) be either [Euler Angles \(default\)](#) (see page 12) or [Orientation Quaternion](#) (see page 12).

Host Prediction is configured per the sensor in the “Sensor Configuration” dialog of the PiMgr tracker management application, as shown in [Figure 17](#):



**Figure 17** Configure Host Prediction

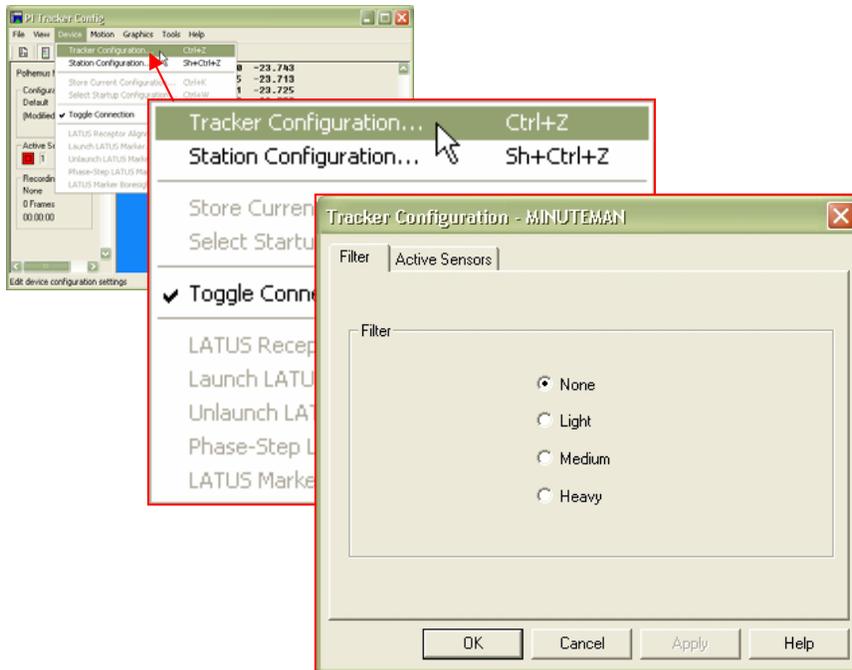
## Filtering

MINUTEMAN incorporates an adaptive filter that provides significant output (“jitter”) reduction while maintaining good overall responsiveness. Four filter settings are available to the user: None, Light, Medium and Heavy.



NOTE: Filtering does not change the update rate of the MINUTEMAN. Medium to heavy filtering may produce perceivable lag in the tracking outputs.

The filter is configured in the “Tracker Configuration” dialog (see [Figure 18](#)) of the PiMgr  tracker management application:



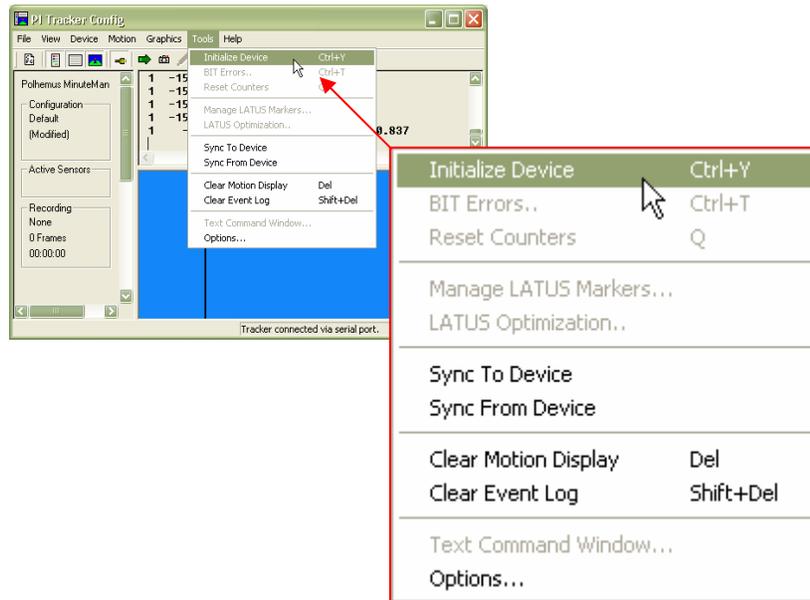
**Figure 18** Configure Filter

### ***Electronic Stabilization Process (ESP)***

The ESP is an innovative adaptive filtering process that analyzes tracker signal noise/jitter and automatically adjusts its acceptance “windows” to smooth the orientation output prior to reporting to the host. This is done dynamically inside the MINUTEMAN processor code while the DSP is analyzing the data variability. ESP provides stabilization over the range of tracker application that outperforms typical adaptive filtering and has the effect of increasing tracker range over larger sensor/E-Pod separation distances. Highest resolutions are attained at close range. Refer to online help for disabling details.

## Soft Reset

MINUTEMAN can be reset without disconnecting the power/USB connection via the PiMgr “Initialize Device” selection in the Tools Menu (see [Figure 19](#)). Note that any soft or hard reset to MINUTEMAN will reset all configuration settings to factory default values.



**Figure 19** Soft Reset

## MINUTEMAN Host Software

The MINUTEMAN Host Software set is found on the MINUTEMAN Host Software CD. See [Initial MINUTEMAN Setup and System Test](#) on page 2 for instructions on installing this software.

### ***PiMgr Tracker Management Application***

The PiMgr application is capable of managing every aspect of MINUTEMAN configuration and control. It may be used on its own to troubleshoot the E-Pod, and to collect, record, save and play back motion data.

PiMgr is launched with the PiMgr desktop and quick launch icons , or from the Start→All Programs→Polhemus Windows menu.

Detailed instruction on the use of PiMgr features can be found in PiMgr's online help program, accessed through the application's main Help menu, the "What's This?" toolbar button , or by pressing F1 anywhere in the PiMgr window.

### ***Polhemus Developer Interface SDK***

For custom applications, the Polhemus Developer Interface (PDI) is available on the CD. This is a C++ programming library complete with sample projects and online help. For detailed instructions on the use of the PDI, refer to the PDI online help program. Launch the PDI online help with the  desktop or quick launch icon.

## **APPENDIX A. Limited Warranty and Limitation of Liability**

Manufacturer warrants that the Product shall be free from defects in material and workmanship for a period of two years from the date of Manufacturer's delivery to the Buyer, or two years and 30 days from the date ownership of Product passed to the Buyer, whichever occurs first, with the exception of FastSCAN, which has a warranty period of only one year. Manufacturer shall, upon notification within the warranty period, correct such defects by repair or replacement with a like serviceable item at Manufacturer's option. This warranty shall be considered void if the Product is operated other than in accordance with the instructions in Manufacturer's User Manual or is damaged by accident or mishandling. Parts or material which are disposable or expendable or subject to normal wear beyond usefulness within the warranty period such as lamps, fuses, batteries, etc., are not covered by this warranty.

In the event any Product or portion thereof is defective, Buyer shall promptly, and within the warranty period, notify Manufacturer in writing of the nature of the defect and return the defective parts to Manufacturer at the direction of Manufacturer's Customer Service representative. Upon determination by Manufacturer that the parts or Products are defective and covered by the warranty set forth above, Manufacturer, at its option shall repair or replace the same without cost to Buyer. Buyer shall be responsible for any import/export duties/tariffs and pay all charges for transportation and delivery costs to Manufacturer's factory for defective parts where directed to be sent to Manufacturer, and Manufacturer shall pay for transportation costs to Buyer's facility only for warranty replacement parts and Products. Removed parts covered by claims under this warranty shall become the property of Manufacturer.

In the event that allegedly defective parts are found not to be defective, or not covered by warranty, Buyer agrees that Manufacturer may invoice Buyer for all reasonable expenses incurred in inspecting, testing, repairing and returning the Products and that Buyer will pay such costs on being invoiced therefor. Buyer shall bear the risk of loss or damage during transit in all cases.

Any repaired or replaced part or Product shall be warranted for the remaining period of the original warranty or thirty (30) days, whichever is longer.

Warranties shall not apply to any Products which have been:

repaired or altered other than by Manufacturer, except when so authorized in writing by Manufacturer; or  
used in an unauthorized or improper manner, or without following normal operating procedures; or  
improperly maintained and where such activities in Manufacturer's sole judgment, have adversely affected the Products. Neither shall warranties apply in the case of damage through accidents or acts of nature such as flood, earthquake, lightning, tornado, typhoon, power surge(s) or failure(s), environmental extremes or other external causes. Warranties shall not apply to any Products if the Products are defective because of normal wear and tear; or  
used for any purpose without obtaining any applicable regulatory approvals.

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The Products are not certified for medical or bio-medical use. Any references to medical or bio-medical use are examples of what medical companies have done with the Products after obtaining all necessary or appropriate medical certifications. The end user/OEM/VAR must comply with all pertinent FDA/CE and all other regulatory requirements.

## APPENDIX B. Specifications

<b>Update Rate</b>	75 Hz per sensor (fixed), simultaneous samples
<b>Latency</b>	2 ms (OS and Host Software dependent)
<b>Number of Sensors</b>	1 or 2
<b>I/O</b>	USB 1.1 or 2.0, WinXP/2K driver provided 17-ft. cable supplied
<b>Static Accuracy</b>	< 2° RMS orientation accuracy at 24 inches
<b>Resolution</b>	0.01° orientation (at 12", using default filter settings)
<b>Range</b>	Approximately 36 in. (90 cm)
<b>Angular Rate</b>	Max: Unlimited Min: 0
<b>Multiple Systems</b>	Up to 4 systems in same environment
<b>Angular Coverage</b>	All-attitude
<b>Data Format</b>	IEEE 754 binary; Euler Angles, Direction Cosines, Orientation Quaternion

**30 KHz – Yellow (Standard)**

**33 KHz – Black**

**28.5 KHz – Red**

**31.5 KHz – Blue**

**Frequency Indicator**

**Prediction Filtering**

Proprietary, host-driven, adjustable 1 – 50 ms.

**Physical Characteristics**

Length: 3.00 inch (7.6cm)

Width: 4.00 inch (10.2cm)

**E-Pod:** Height: 1.40 inch (3.6cm)

Weight: 4 oz. (113.4g)

E-Pod has standard tripod screw mount, 1/4-20UNC

Length: 1.40 inch (3.6cm)

Width: 0.66 inch (1.7cm) w/o mounting flanges,

**Sensor:** 1.48 inch (3.8cm) w/ mounting flanges

Height: 0.78 inch (2.0cm)

Weight: 0.3 oz. (8.5g)

**Power Requirements**

Power provided via USB, 5VDC at 0.5A

**Temperature**

0° – 50° C

## APPENDIX C. Customer Service

If problems are encountered with the MINUTEMAN or if you are having difficulty understanding how the commands work, help is just a telephone call away.

Call Polhemus at the numbers listed below and select “2” for Customer Service and then “1” for Technical Support. Polhemus is open Monday through Friday, 8:00 AM to 5:00 PM, Eastern Standard Time. For the most part, our customer service representatives are usually able to solve problems over the telephone and get you back into the fast lane right away.

Help is also available on our web page at [www.polhemus.com](http://www.polhemus.com). Simply double-click Technical Support, and then click [techsupport@polhemus.com](mailto:techsupport@polhemus.com) to send us an email describing the problem or question.

If a problem requires repair of your MINUTEMAN, the customer service representative will issue a Return Merchandise Authorization (RMA) number and you may then return the system to the factory. ***Do not return any equipment without first obtaining an RMA number.*** Please retain and use the original shipping container, if possible, to avoid transportation damages (for which you or your shipper would be liable). If your system is still under warranty, Polhemus will repair it free of charge according to the provisions of the warranty as stated in [APPENDIX A](#) of this document. The proper return address is:

**Polhemus  
40 Hercules Drive  
Colchester, VT 05446  
Attention RMA # \_\_\_\_\_**

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