



# **PHANTOM® Premium Device Guide**

**For Models 1.0 / 1.5 / 1.5HF / 1.5 6DOF**



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Hardware usage guidelines are provided to assist the user in protecting the effectiveness and life of the device. They are not intended as recommendations for the prevention of repetitive stress injury, carpal tunnel syndrome or any other conditions, injuries or disorders; users should consult their own physicians. By using the PHANTOM device, the user acknowledges and agrees that SensAble shall have no liability for any disorder, condition or injury arising from any use of the device.

**Warning** *Do NOT open the PHANTOM device.* Attempting to open or repair the device by anyone other than a certified authorized service center voids the manufacturer warranty and hardware maintenance contract. Send to SensAble for servicing.

## Questions or Comments

If you have any questions for our technical support staff, please contact us at [support@sensable.com](mailto:support@sensable.com). You can also phone 1-888-SENSABL (U.S.A. only) or 1-781-937-8315 (International).

If you have any questions or comments about the documentation, please contact us at [documentation@sensable.com](mailto:documentation@sensable.com).

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# Preface

This guide covers the currently shipping PHANTOM® Premium 1.0 and 1.5 haptic devices, including the 1.5 High Force device. The information contained in this manual was current at the time of publication. Visit [www.sensable.com](http://www.sensable.com) for the latest information

## About This Guide

The PHANTOM Premium User's Guide describes the process of installing the required device drivers for your new PHANTOM Premium haptic device and connecting the hardware. You will also find information on how to use the device and other information about the device.

We've worked extensively to ensure that the PHANTOM Premium device and device drivers install and work smoothly. If you experience any problems in the installation or use of your device, please contact technical support as indicated in Appendix A: "Customer Support" of this document. Your feedback and input are essential! Please do not hesitate to contact us with technical questions and suggestions for improvement.

Please note, if you are installing your device on a non Microsoft® Windows® OS, you will find additional information in a separate document shipped with your product.

## How This Guide Is Organized

This guide is divided as follows:

**Chapter 1, Getting Acquainted**, describes the PHANTOM Premium device and other items that were shipped with the device.

**Chapter 2, Installing the PHANTOM Premium Device**, describes how to install the software necessary to run this product on PCs under Windows 2000 or Windows XP and how to connect the PHANTOM device to your computer. Please note that if

you are installing your device on a non Microsoft Windows OS, you will find additional information about installing the PHANTOM Device Drivers in a separate document that shipped with your product.

Additionally, there are several appendices including how to contact customer support and information for troubleshooting your device.

## Typographical Conventions

This guide uses the following typographical conventions:

Convention	Description	Example
<Italics>	A variable	<Installed Directory>/files.
<b>Bold</b>	Keywords, actual user input, directory paths or examples.	Click <b>Ok</b> .
Greater Than (>)	Indicates a menu pick.	<b>Tools &gt; Options</b>
<b>Note, Warning, Important</b>	Calls out important information.	

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# 1

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## Getting Acquainted

The following topics are described in this chapter:

- The contents of the shipping box
- The PHANTOM Premium haptic device
- The proper handling of the device

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### Shipping Box Contents

In your shipping box you should find the following:

- **The PHANTOM Premium haptic device**
- **This PHANTOM Premium User's Guide**
- **Parallel Port Cable:** The cable is used to attach the computer's parallel port to the PHANTOM Premium. The cable is an IEEE 1284 EPP cable with a ferrite bead that provides an impedance at 100mhz of 199 ohms or greater.
- **PHANTOM Device Drivers CD:** This CD includes all of the drivers needed to set up and run the PHANTOM Premium as described in the next sections. (If you also purchased OpenHaptics®, the PHANTOM Device Drivers will be found on that Product CD.)
- **Power Cord:** The power cord connects the PHANTOM Premium to the wall outlet.
- **(Optional) Accessory Bag:** Contains thimble gimbal and stylus. May contain the encoder gimbal if ordered. Note that the encoder gimbal must be installed before connecting the device to your PC. See Appendix D: "Installing/Removing the Encoder Gimbal" for information. The accessory bag may also contain the Pinch end effector(s) (thumb-pad and/or scissors) if they were

ordered (6 DOF only). Note that these attachments must be installed before connecting to the PC. For more information, see *Appendix E: Working with Pinch End Effectors*.

**Note** Your box may also include other SensAble™ software purchased with your order.

If any items are missing, please call SensAble Technologies at +1-888-SENSABL (US only) or +1-781-937-8315 (US and outside the US).

**Important** Do NOT throw away the packaging materials. If for any reason you need to ship the device in the future, you will want to reuse these materials to reduce the risk of damage to the device.

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## The PHANTOM Premium Haptic Device

The SensAble Technologies PHANTOM product line of haptic devices makes it possible for users to touch and manipulate virtual objects. The PHANTOM Premium enhances productivity and efficiency by enabling the most intuitive human/computer interaction possible, the ability to solve problems by touch. The PHANTOM system has been widely recognized as the finest 3 degree-of-freedom (3DOF) force-feedback device available. It is unlike any other haptic device in that it offers realistic 3D Touch™ technology, the ability to feel the properties of virtual 3D objects, with higher fidelity and lower cost than other force feedback devices.

For the first time computer-generated objects can be created, manipulated, and deformed just like their real counterparts in the most natural way possible...by hand. Mechanical engineers can perform maintenance analyses and check tolerances of virtual assemblies, model makers can sculpt virtual digital mock-ups, molecular chemists can fit drug molecules into virtual human receptor sites, surgeons can practice on virtual patients, all digitally, but with an incredible sense of realism.



## Proper Handling of the PHANTOM Premium Device

**Warning** Gripping and lifting the PHANTOM device improperly may damage it. To reduce the risk of damage, please follow the instructions below.

### Handling

**PHANTOM Premium lifting points** The PHANTOM Premium is a sensitive piece of electronic equipment. Lift by placing your hands under the bottom of the base, and support the base when moving it (See 1 in Figure 1-1). Lifting by any of the moving parts may affect the unit's performance and risks damaging the device.

**Stylus with Switch** The stylus is the “handle” or “pen” you use to interact with virtual objects (See 2 in Figure 1-1). Your forefinger or thumb should rest above the raised switch when using the device. Like a mouse button, the switch is used differently in each application.

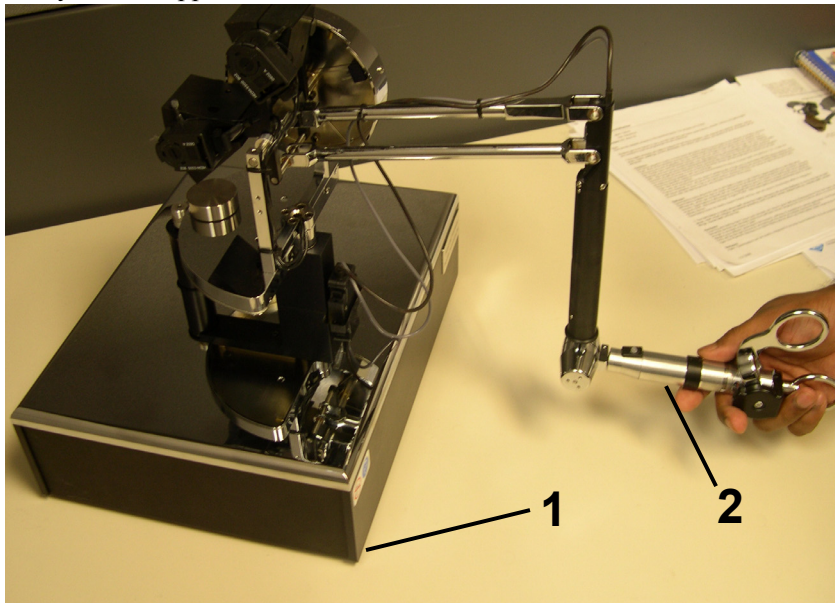


FIGURE 1-1. PHANTOM Premium (1.5/6DOF Model Shown)

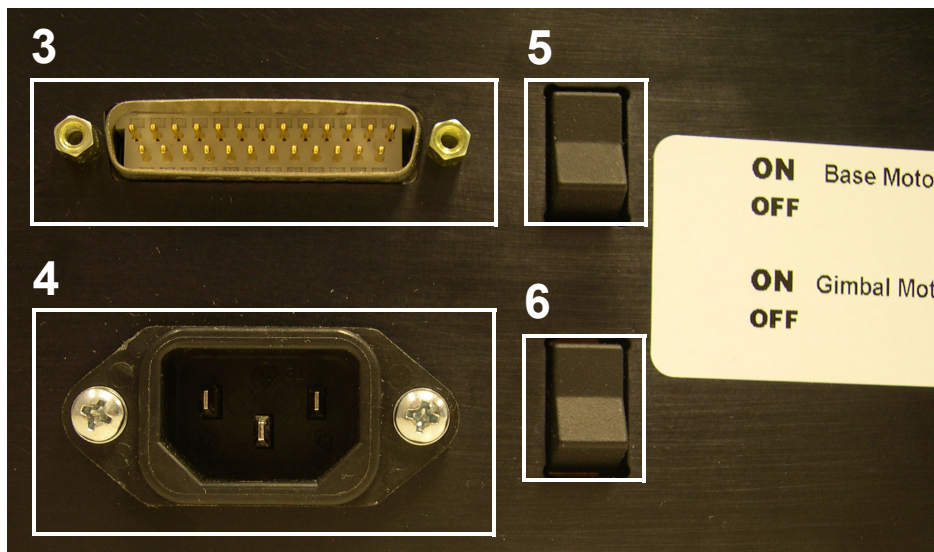


FIGURE 1-2. Connectors and switches on the rear of the PHANTOM Premium 1.5/6DOF

**Parallel Port To Computer** The male bottom connector is connected to the computer's parallel port using the supplied IEEE-1284 rated cable. (See 3 in Figure 1-2).

**AC Power Plug** The AC Power Plug is connected to the wall outlet with a power cord. The integral switching power supply in the base of the device works for both 115V and 230V AC supplies.(See 4 in Figure 1-2).

**Motor power switch for base motors (1.5/6DOF Only)** The first motor power switch is used to cut off the power to the three base motors which are responsible for translational force feedback. When the switch is in the “ON” position the motors and encoders are both connected. When the switch is in the “OFF” position, the encoders are still powered but the motors are not. This is a handy feature for debugging new haptics code. (See 5 in Figure 1-2).

**Motor power switch for gimbal motors (1.5/6DOF Only)** The second motor power switch is used to cut off the power to the three gimbal motors which are responsible for rotational torque feedback. When the switch is in the “ON” position

(see 6 in Figure 1-2) the motors and encoders are both connected. When the switch is in the “OFF” position, the encoders are still powered but the motors are not. This is a handy feature for debugging new haptics code.

**Protecting the device from damage** It is best to place the unit firmly on the desktop and away from edges to reduce the risk of damage to the device from a direct, unintentional elbow hit.

Remember Do NOT attempt to lift the unit or relocate it on the desk by pulling on the stylus. This may result in severe damage to the device.

**Positioning the PHANTOM device** The correct placement of the device will vary from one user to another and based on what you are doing. You may want to experiment with placement that feels right for you. Working with the device should be comfortable and should not put any undue strain on your wrist or forearm. Remember to take breaks often to stretch your hands, wrists, and elbows.

### **Caring for your PHANTOM Device**

- DO start the device at the neutral position without fail.
- DO grip the handle firmly in an application that applies torques (1.5/6DOF).
- DO use small hand motions near the neutral position.
- DON'T drop the device.
- DON'T apply sharp impact forces to any part of the device.
- DON'T ram any movable member into a hard stop with great force.
- DON'T let go of the device in the middle of an application.
- DON'T twist the handle past its physical limitations.
- Try to minimize unnecessary vibration to the device.
- Turn off the switches in the back to debug without forces and torques. (1.5/6DOF).

## 1 GETTING ACQUAINTED

### *Proper Handling of the PHANTOM Premium Device*

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# 2

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## Installing the PHANTOM Premium Device

This chapter will provide system requirements and describe, step by step, how to install the PHANTOM Premium haptic device.

The installation is done in two steps:

- 1 Install and configure the software, the PHANTOM Device Driver (PDD), that allows your computer to communicate with the PHANTOM device.
- 2 Connect the PHANTOM Premium device to your computer and power source. These instructions are for the currently shipping premium devices. If you have an older PHANTOM Premium model, consult the documentation that shipped with your device.

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### Cautions

The PHANTOM Premium device must be installed in accordance with the applicable requirements.

It is important to exercise care when working with force feedback devices:

- Read the manual thoroughly prior to using your PHANTOM Premium
- DO NOT place your fingers inside the mechanism. At the installation site, access to motors and pulleys should be prevented.
- DO NOT put your face in the workspace of the PHANTOM Premium. Safety glasses are recommended.
- As a user of this product and software, you accept full responsibility for assuring that the device is used in a safe and responsible manner.

## System Requirements

The PHANTOM Premium haptic device requires certain hardware and software components to be able to work properly:

- An Intel® processor based personal computer (A minimum of Pentium® II class processor is recommended) or select AMD® processor personal computer.
- Windows 2000 or Windows XP.
- A hard drive with 30 MB of disk space.
- EPP IEEE 1284 parallel port interface; FireWire with a PHANTOM Communication Converter (PCC - sold separately); or FireWire Card (requires IEEE-1394a-2000 compliant FireWire port).
- There are no specific memory requirements; however, a minimum of 32 MB RAM is recommended for overall system performance.
- The PHANTOM Device Driver (PDD) version 4.2.105 or later.

Please visit [www.sensable.com](http://www.sensable.com) for the most current system requirements information, including the latest drivers.

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## Installing the PHANTOM Device Drivers

To enable communication between your computer and the PHANTOM device, you must install a software driver called the PHANTOM Device Drivers (PDD).

Actual installation procedures may vary slightly from the instructions given here depending on which version of the PDD you are installing and which operating system you are running. Instructions are given for the latest PDD version and for Windows XP, with exceptions noted for Windows 2000. For installation instructions on other operating systems or for older PHANTOM models, see the additional documentation shipped with your device or software product or contact customer support.

**Note** As with most other software packages, you must have administrator privileges on the machine in order to install software. If you are unfamiliar with installing software or do not have administrator privileges, please have your System Administrator execute the following steps for you.

To install the device drivers:

- 1 Insert the CD into the CD-ROM drive.

**Note** If you purchased a SensAble software product, your PDD drivers may be found on your software product CD.

- 2 In Windows Explorer, locate the drive letter associated with your CD-ROM drive and double-click it.
- 3 In the CD's directory, locate the PHANTOM Device Drivers folder and double-click to open it.
- 4 Double-click **setup.exe** to begin the installation.
- 5 The InstallShield Wizard will appear. Click **Next**.
- 6 **Accept** the terms of the license agreement and Click **Next**.
- 7 On the Setup Type window, make sure that "Complete" is selected. Click **Next**.
- 8 The next window will read "Ready to Install the Program." Click **Install** to begin the installation. Depending on the PDD you are using, you may see a status bar.

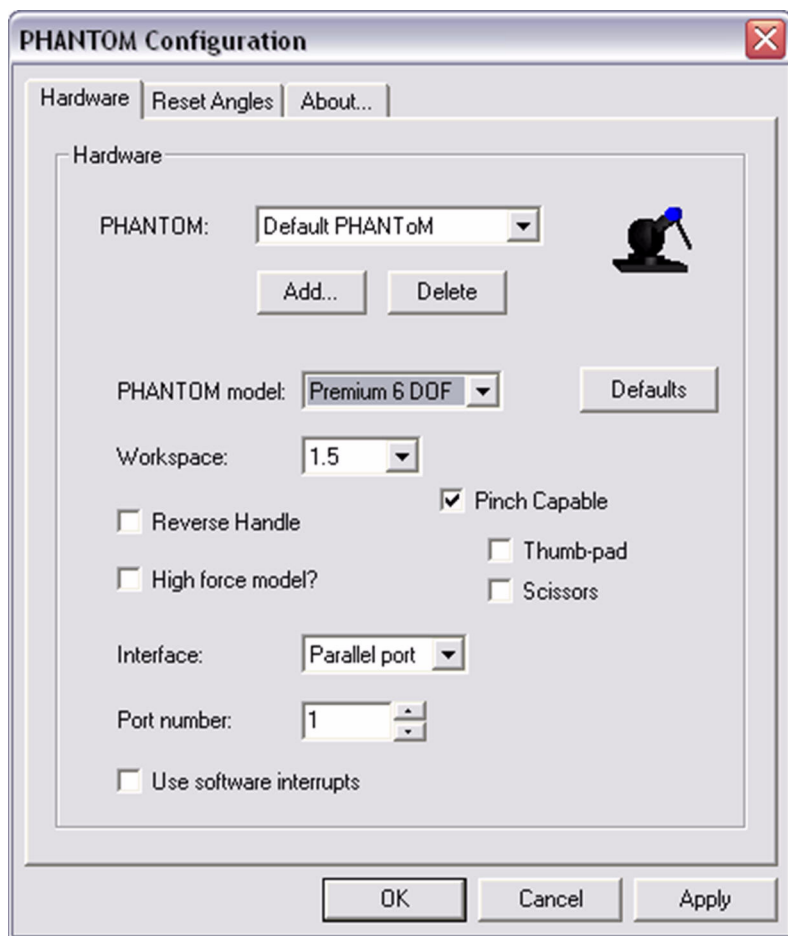
**Windows XP Users** A dialog will appear informing you that components of the software have not passed Windows Logo testing. This testing is currently underway. YOU CAN CONTINUE THE INSTALLATION PROCESS WITHOUT HARMING YOUR SYSTEM. Click "Continue Anyway" each time you see this dialog.

**Windows 2000 Users** A dialog will appear informing you that a digital signature was not found. Click **Yes** to continue with the installation. Click **Yes** again.

- 9 Next, you need to configure for your PHANTOM device. On the "PHANTOM Configuration" screen, configure the appropriate settings (note that some of the settings described in this section may not appear in the dialog, depending on what is selected under PHANTOM model):

## 2 INSTALLING THE PHANTOM PREMIUM DEVICE

### *Installing the PHANTOM Device Drivers*



- a Select your model, **Premium A** or **Premium 6 DOF**, from the “PHANTOM model” pull-down menu.
- b Specify the proper **Workspace** size, 1.0 or 1.5.
- c Gimbal Encoders (may not appear, depending on model selected) - If not using a gimbal encoder, set to None.
- d If you are using a reverse handle, click to select the **Reverse Handle** checkbox.



- e If you have a 1.5 High Force, click to select the **High Force Model?** checkbox.
  - f When Premium 6 DOF is selected under PHANTOM model, settings specific to Pinch end effectors will appear in this dialog. If you are using a device with a pinch-capable handle, click to select the **Pinch Capable** checkbox. To use a the Pinch thump-pad end effector, click to select the **Thumb-pad** setting. To use the Pinch scissors end effector, click to select the **Scissors** setting. For more information on the Pinch end effectors, see *Appendix E: Working with Pinch End Effectors*.
  - g Select the **Interface**:
    - For a 1.0, 1.5, or 1.5 High Force, select the Parallel Port card option from the Interface field.
    - For the 1.5/6DOF models, the interface will default to Parallel port; no other interface type is supported. You will also have the option of selecting **Reverse Handle**.
  - h **Port Number** The main parallel port will be 1. If using an Add-in PCI parallel card, it could be any port number. To determine the port number check the following:
    - Right-click **My Computer > Properties > Hardware tab > Device Manager > Ports**. In the list of ports locate the PCI card. Next to the card you will see LPT# where # is the port number.
  - i **Use software interrupts** should only be used when using a PCI-based add-in parallel port card. It should be selected only if normal interrupts are not working.
  - j Click **OK**.
- 10** The next window will read “InstallShield Wizard Completed.” Select **Yes** to restart your computer. Click **Finish**.

At this point the device driver is installed and you are ready to connect your haptic device.

## Connecting the PHANTOM Premium Device

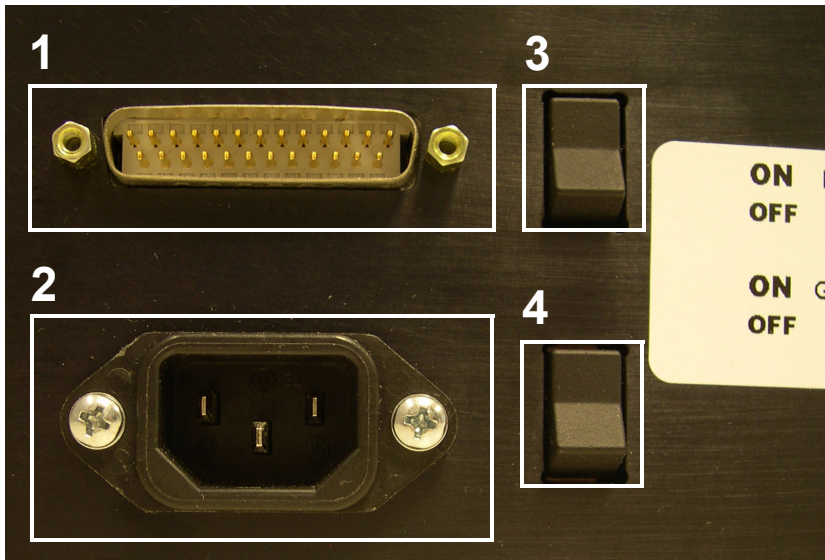
(These instructions are for the currently shipping premium devices. If you have an older PHANTOM Premium model, consult the documentation that shipped with your device.)

In this section you will setup the PHANTOM device and plug in all of the cables.

**Note** If you ordered an Encoder Gimbal, you first need to install that component. See Appendix D: “Installing/Removing the Encoder Gimbal”.

To connect a PHANTOM Premium to your computer:

**Tip** Lift by the metal covers and support the base when moving the PHANTOM Premium. Lifting by any of the moving parts may affect the unit's performance and risks damaging the device.



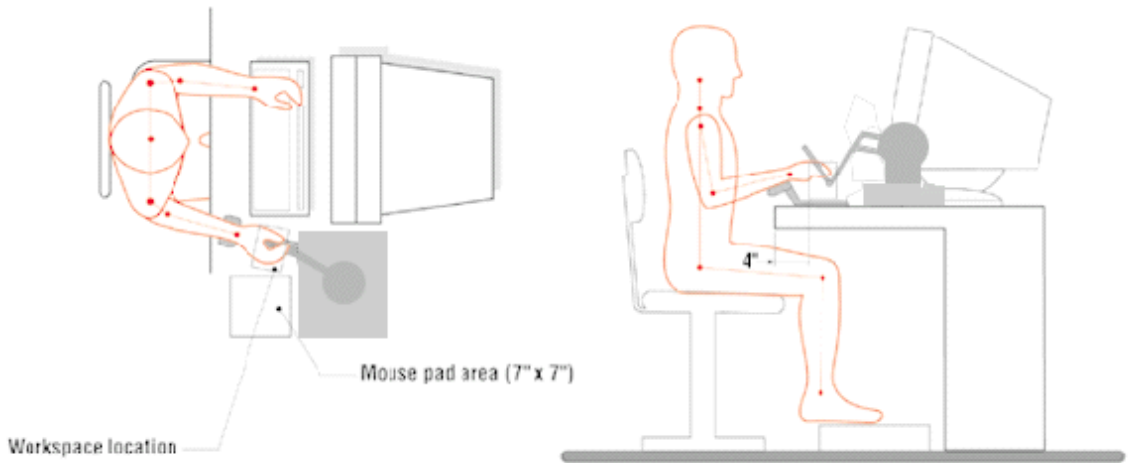
**FIGURE 2-3.** Rear of a select PHANTOM device shows the cable connectors.

- 1 Attach the male end of the supplied IEEE-1284 rated cable to your computer's parallel port.

The high demands of the PHANTOM Premium on the parallel port require the PHANTOM Premium to have a dedicated parallel port for its use. If you are currently using your parallel port for a printer, dongle or other peripheral, you will need to install an additional parallel port card in your system. You can choose whether to connect the PHANTOM Premium or the other peripherals to the additional card.

- 2 Plug the female end of the cable to the male connector (Item 1 in Figure 2-3) of the PHANTOM Premium.
- 3 Plug the power cord into the AC power socket (Item 2 in Figure 2-3) of the PHANTOM Premium.
- 4 Plug the power cord into an available outlet (for 110V the outlet must be rated for at least 2 Amps, for 220V: 1 Amp).
- 5 Leave the Gimbal and Base motor switches (Items 3 and 4 in Figure 2-3) in the "ON" position for normal operation. These switches can be used to cut off motor power for debugging purposes. (1.5/6DOF model only).

- 6 Position the PHANTOM Premium.** Place the PHANTOM Premium to the inside of your mouse, shown below. This should place the device in a comfortable position. See also “Proper Handling of the PHANTOM Premium Device” on page 3.



**FIGURE 2-4.** Suggested location of the PHANTOM Premium.

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## Calibrating the PHANTOM Premium Device for Accuracy

After installing the driver and connecting your PHANTOM Premium device to your computer you will need to calibrate the device.

- 1 From Start > Programs > SensAble open PHANTOM Test.
- 2 Put the PHANTOM into neutral position. Neutral position is described as when the 4 rotary joints are lined up. See Appendix B: "Maximizing Positioning Accuracy" for more detailed information about position accuracy.
- 3 Press the space bar on your keyboard to reset.

**Note** For information on calibrating the Pinch or Scissor attachments, please see *Appendix E: Working with Pinch and Scissor Attachments*.

# Appendix A: Customer Support

**Warning** DO NOT OPEN THE UNIT, doing so will void your warranty.  
There are no serviceable components. Return to SensAble for servicing.

If you encounter any difficulties, you can obtain Technical Support through the following three channels:

- If you purchased your PHANTOM Premium device from a reseller/distributor, please contact them first.
- SensAble Technologies Customer Support can be reached via e-mail at [support@SensAble.com](mailto:support@SensAble.com).
- SensAble Technologies Customer Support can also be reached via telephone:
  - In the United States: 1-888-SENSABL (1-888-736-7225)
  - Outside the United States: +1-781-939-7444



# Appendix B: Maximizing Positioning Accuracy

The objective of this technical note is to help you achieve a high level of positioning accuracy in the PHANTOM devices as specified in our product literature.

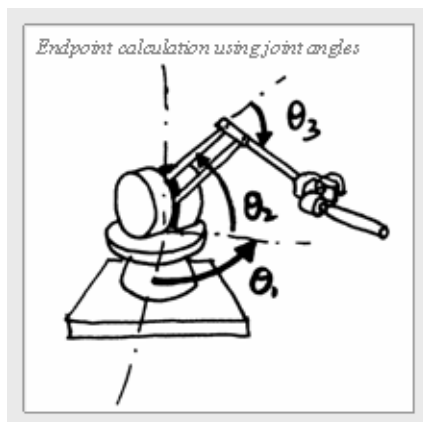
PHANTOM devices have excellent inherent repeatability under no-load conditions. However, they can only be accurate if they have been initialized properly. The proper procedure for initialization is outlined in this note.

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## Why initialization matters

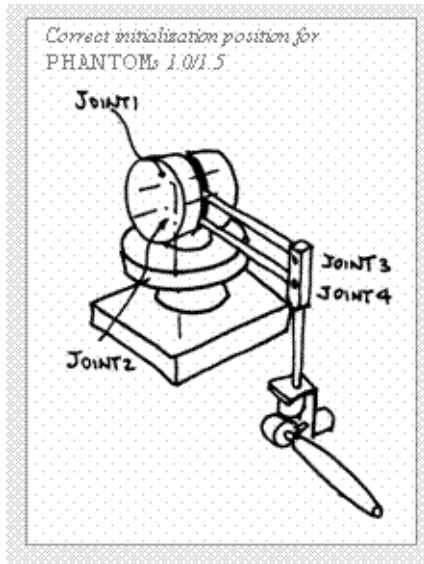
All PHANTOM devices are equipped with incremental rotary encoders, which measure the joint angles of the PHANTOM mechanism. These measurements are then used to calculate the endpoint position in Cartesian space, based on the linkage structure, link lengths and other such parameters.

This method of arriving at the endpoint position implies an absolute knowledge of the joint angles. However, incremental encoders can only provide angular measurements relative to the joint angles at which the system “woke up” at initialization time. To obtain absolute angular measurements, the system must initialize at a known position and orientation, often referred to as neutral position.



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## Initialization position for PHANTOM Devices



To keep the initialization procedure simple, we have chosen an easily recognized point in the center of the workspace of the PHANTOM as neutral position. Roughly speaking, the optimal startup position involves keeping the first link horizontal and perpendicular to the front face of the base, and the second link vertical and pointing down from the first. If there is an encoder gimbal, the face of the gimbal with a label indicating “This side faces the PHANTOM” should be vertical and it should face the base of the PHANTOM. The thimble or stylus should be horizontal in the plane of the first and second linkages.

The goal of this procedure is to line up the four rotary joints of the PHANTOM

4-bar linkage to form a rectangle. If the two joints on the short linkage closest to the base are called Joints 1 and 2, and the joints on the second linkage are called Joints 3 and 4, the lines between Joints 1 and 3 and Joints 2 and 4 must be horizontal, and the lines between Joints 1 and 2 and Joints 3 and 4 must be vertical.

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## To eyeball or not to eyeball

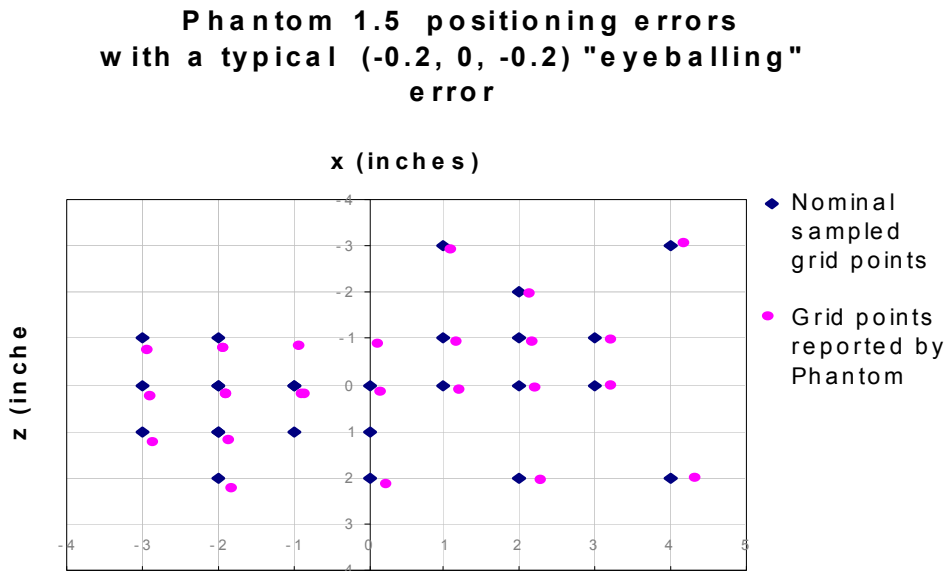
Given that the initialization position dictates future positioning accuracy of the PHANTOM, is it sufficient to eyeball the startup position or is it necessary to create a fixture to ensure accurate and repeatable system initialization?

The answer to that question depends greatly on the application. The following figure shows typical positioning errors for a PHANTOM 1.5 when the initialization position is translated from the optimal startup position by an “eyeballing” error of 0.2" in the -x and -z directions. The best-case error is around the initialization point



with the errors growing larger near the edges of the workspace. Furthermore, there is some skewing of the coordinate system. Due to the error in reported position, the forces presented to the user will also be similarly skewed.

However, the human is an imprecise position and force measurement device and such differences are generally not perceivable. For applications in which a single PHANTOM is used to present forces in a virtual reality simulation, eyeballing is generally adequate. On the other hand, for applications in which position is critical, such as teleoperation, 3D digitization or operation of two PHANTOM s in the same virtual space, it is generally advisable to create a jig for accurate initialization.



**Figure A-1: PHANTOM 1.5 Positioning errors with typical eyeballing error**

## B MAXIMIZING POSITIONING ACCURACY

# Appendix C: Configuring Multiple Devices

If you want to use more than one PHANTOM haptic device with your computer, you can create as many as 20 uniquely named PHANTOM configurations. Each named PHANTOM configuration can refer to a particular system configuration that you use frequently. Which device to use is defined by the software application which uses it.

To create a new PHANTOM configuration use the PHANTOM Configuration Utility.

- 1 From the **Start** menu, open the **Control Panel**. Select **PHANToM Configuration**. The PHANTOM Configuration window opens.
- 2 On the hardware tab, click **Add**.
- 3 Enter a name to call that device, click **OK**.
- 4 From the PHANTOM model menu, select the **correct model**.
- 5 Click **OK**.

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## Dual Configurations

The Dual Configuration settings only apply if you want to set up a pair of PHANTOM devices to work in tandem with each other. You must have created at least two PHANTOM devices as described above before the Dual Configuration tab can be used. Once you have created at least two devices, go to the Dual Configuration area and select the PHANTOM devices you would like to use in a paired configuration. Then, enable the check box to turn the dual configuration on.



# Appendix D: Installing/ Removing the Encoder Gimbal

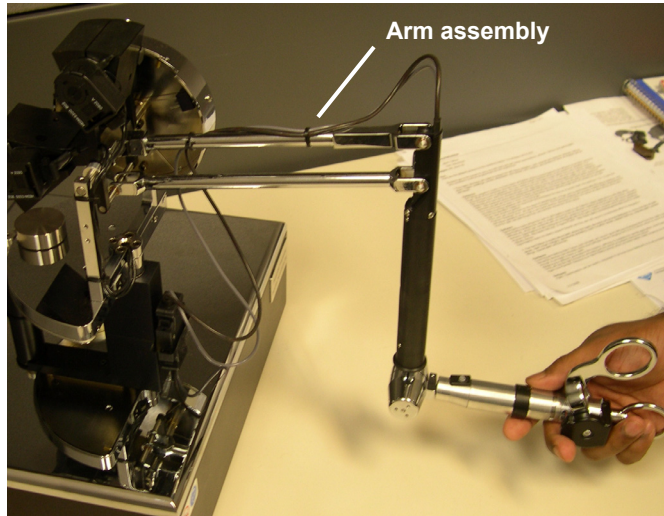
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## Adding the Encoder Gimbal and counterweights to a PHANTOM Premium

- 1 If you previously connected the PHANTOM device, unplug the power and parallel cables.
- 2 Loosen the #4-40 set-screw in the last link using the hex key provided (.050") (SensAble part number 01641).
- 3 Remove the thimble-gimbal from the last link by pulling it out with a slight force.
- 4 Insert the bare shaft of the encoder gimbal assembly into the end of the last link of the PHANTOM Premium.
- 5 Lightly tighten the set-screw. Be careful not to tighten it too much; it could strip the threads and/or mar the shaft.
- 6 Pass the 26-pin connector between the upper and lower arms in the arm assembly.
- 7 Plug the 26-pin connector into the socket located on top of the PHANTOM Premium.

## D INSTALLING/REMOVING THE ENCODER GIMBAL

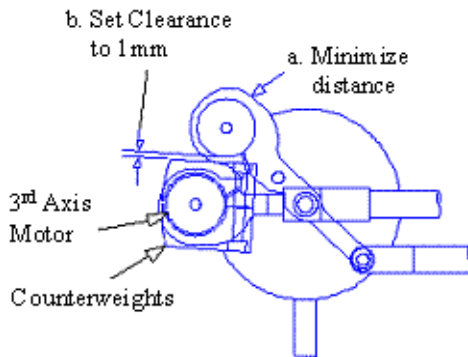
- 8** Using the small cable ties included, fasten the cable to the mechanical arm so that the cable will not interfere with the movement of the PHANTOM Premium in any way. Be sure to leave enough slack near the encoder gimbal so that it can rotate 360. A dressed



- PHANTOM Premium 1.5 should only have three ties: #1 on the gimbal arm, #2 on the upper bar, and #3 on the front of the left support facing towards the back of the unit.
- 9** Cut the excess material from the ends of the cable ties.
- 10** Plug in the power and parallel cables.

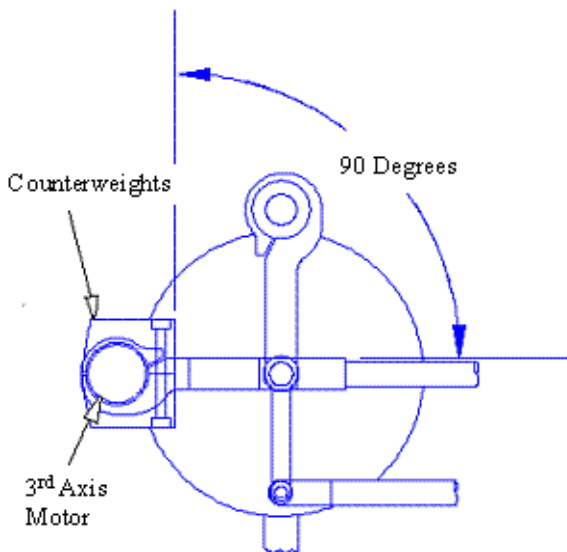
## For a PHANTOM Premium 1.0

Position the counterweights on the 3rd axis motor as shown at right, being careful to avoid the motor driver wires. The counterweights should be approximately 1mm (.040") away from the motor mount in the motor axis direction. You may have to bend the motor driver terminals to 60° away from the motor to make room for the counterweights; do this carefully. With a 9/64" hex key (provided), insert and tighten two 8-32 screws just enough to hold the counterweights in place. Now hold the two motors together, loading them against the mechanical stops and minimizing the distance between them (a). Rotate the counterweights until there is approximately 1mm (.040") clearance as shown (b) and tighten the 8-32 screws to secure them.



## For a PHANTOM Premium 1.5

Position the counterweights on the 3rd axis motor as shown at right, being careful to avoid the motor driver wires. The counterweights should be perpendicular to the PHANTOM Premium's arms. The counterweights should be approximately 1mm away from the motor mount in the motor axis direction. You may have to bend the motor driver terminals to 60 away from the motor to make room for the counterweights; do this carefully. Insert and tighten two 8-32 screws to secure them.





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## Removing the Encoder Gimbal and counterweights from a PHANTOM Premium

- 1 Unplug both the power and parallel cable from the PHANTOM.
- 2 Unplug the 26 pin connector on the PHANTOM Premium base.
- 3 Cut the cable ties that route the cable with the 26 pin connector. Be careful not to cut any part of the cable. Note the routing of the cable as you take it off.
- 4 Using the Hex key provided (0.050") (SensAble part number 01641), loosen the #4-40 set-screw (SensAble part number 01509) located near the end of the last link.
- 5 Pull the encoder gimbal assembly out of the last link. The gimbal should slide out with a minimal amount force.
- 6 Hold both counterweight pieces in one hand to avoid dropping them. Using a 9/64" hex key (SensAble part number 01629), remove the two screws in the counterweights and remove the counterweights.
- 7 Insert the bare shaft of the thimble-gimbal into the end of the last link. Be sure that the shaft is inserted as far into the last link as possible, to preload the bearings and prevent any play in the device.
- 8 Lightly tighten the set-screw. Be careful not to tighten it too much: it could strip the threads and/or mar the shaft.
- 9 Plug in the power and parallel cables.

## D INSTALLING/REMOVING THE ENCODER GIMBAL

# Appendix E: Working with Pinch End Effectors

The PHANTOM 6 DOF family of haptic devices enables attaching interchangeable end effectors that provide pinch functionality. There are two pinch-capable grips: thumb-pad and scissors (examples available in the following pages).

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## Requirements

- A Pinch-capable PHANTOM Premium device (1.5/6DOF, 1.5HF/6DOF, or 3.0/6DOF).
- PHANTOM Device Driver (PDD) version 4.2.105 or later.
- OpenHaptics v2.x BETA. **Pinch end effectors will not work with OpenHaptics v2.0.**
- Windows XP (32 or 64-bit)

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## Specifications

- Range of Motion: 0 to 30 degrees
- Digital Encoder: +/- 2% linearity potentiometer
- Force Feedback: None

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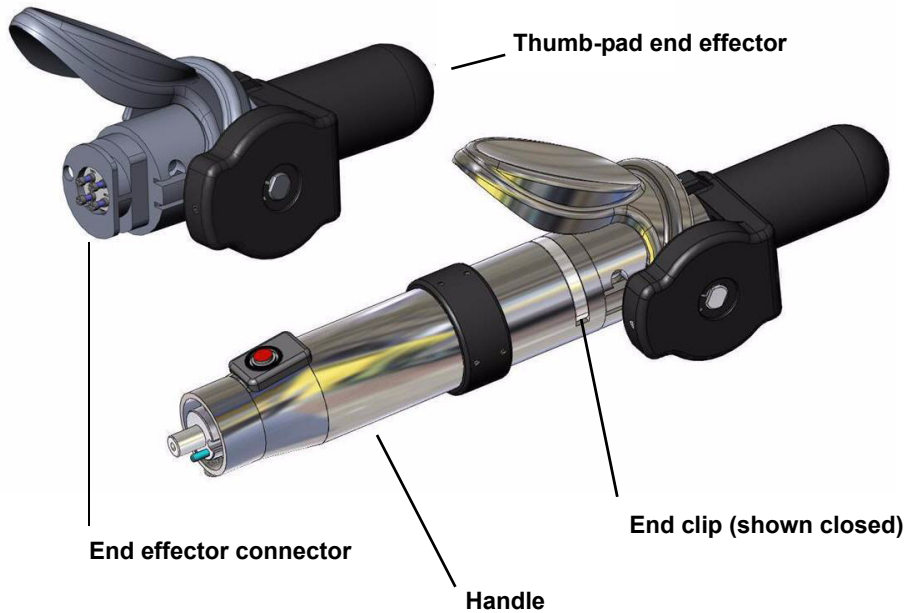
## Installing or Removing the End Effectors

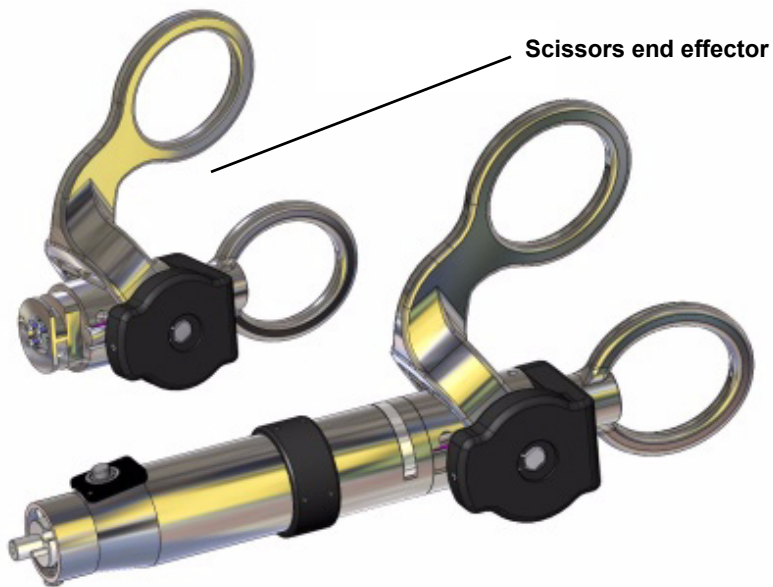
Follow the instructions below to install or remove the Pinch end effectors (thumb-pad and scissors).

## Installing the End Effector

- 1 Remove the end cap by opening the end clip and carefully sliding out the cap.
- 2 Align the male connector of the end effector with the female end of the 6 DOF handle and push to insert it. Make sure that the vertical edge of the end effector connector align with the vertical edge of the 6 DOF handle connector.
- 3 Close the end clip tightly to keep the end effector in place.

The diagrams on the following page show the thumb-pad and scissors attachments before and after assembly.





## Removing the End Effectors

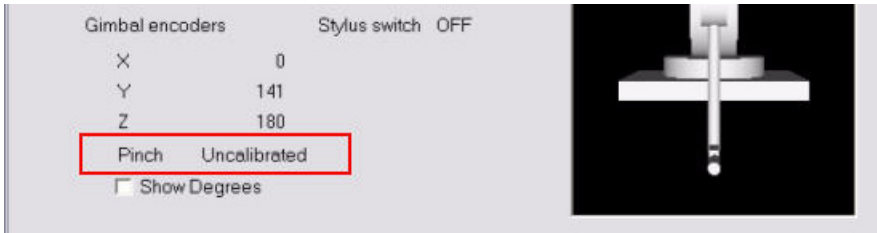
- 1 Open the end clip.
- 2 Carefully disconnect the end effector from the 6 DOF handle. Make sure to apply the end cap to the 6 DOF handle whenever an end effector is not connected.

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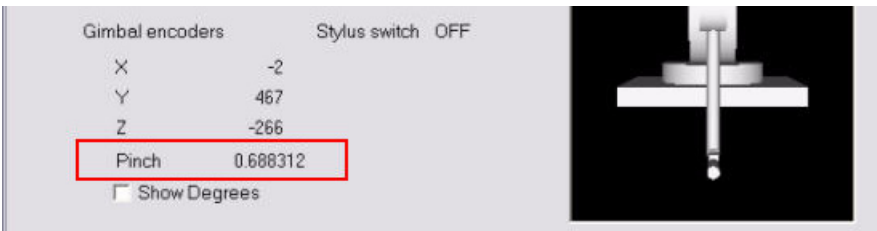
## Calibrating the End Effectors

After you have installed the PHANTOM Device Driver (PDD) and have connected the PHANTOM device to your computer, you will need to calibrate the device and the thumb-pad or scissors end effectors. End effectors are calibrated through the *Read encoders* tab of the PHANTOM Test dialog. To do this, follow the steps on the next page.

- 1 From **Start > Programs > SensAble**, open **PHANTOM Test**.
- 2 Hold the PHANTOM device in the neutral position (with the 4 rotary joints lined up) and press the **Space bar** on the keyboard.
- 3 The Pinch option in the dialog will report a status of *Uncalibrated*.



- 4 Close (press) the end effector completely, and press the **Space bar** on the keyboard.
- 5 Open (release) the end effector completely, and then press the **Space bar** again.
- 6 The Pinch option in the dialog should now show continuous readings from the end effector encoder (as shown). This indicates that the end effector is calibrated and ready to use.



**Note** When the thumb-pad end effector is completely open (released), the Pinch reading corresponds to **zero**. (If using scissors, it corresponds to **one**.) When the thumb-pad end effector is completely closed (pressed completely), the Pinch reading corresponds to **one** in normalized encoder values. (If using scissors, it corresponds to **zero**.) The intermediate positions are distributed between zero and one (or vice versa, if using scissors).

# Appendix F: Troubleshooting

**Warning** Do NOT open the PHANTOM device. Attempting to open or repair the device by anyone other than a certified authorized service center voids the manufacturer warranty and hardware maintenance contract. Send to SensAble for servicing.

## **The device isn't calibrated, what do I do?**

Place the PHANTOM Premium device in neutral optimal startup position and press the Space bar on the keyboard. For information about this optimal position see Appendix B: "Maximizing Positioning Accuracy".

## **Unable to Communicate with the PHANTOM - Configure BIOS Parallel Port Mode**

Depending on your computer, you may have to configure your system's BIOS for communicating to the parallel port via the EPP or EPP+ECP communication protocols. If you encounter communication problems, please see your system administrator or contact your reseller.

## **PHANTOM Premium suddenly does not operate as expected**

If your PHANTOM was previously working properly but you are now encountering trouble, call SensAble Technologies immediately for further assistance. Do not proceed further until you call our toll-free number (1-888-SENSABL) and ask for Customer Support, or email SensAble at [support@sensable.com](mailto:support@sensable.com).

When contacting Support, you may be asked to run the "PHANTOM Test" application to help with diagnosis. This application can be found in the directory where you installed the PHANTOM Device Drivers or via the Start > Programs > SensAble menu.

The following describes the basic features of this test application which you should be prepared to run.

**Select** Select the PHANTOM device which you want to test. Usually this will be "Default PHANTOM".

**Read Encoders** The values being sensed for the positions and rotations of the device are dynamically displayed in the window. It additionally will display whether the stylus switch (if it exists) is pressed or not and whether you are holding the device (presence switch=on). The picture of the PHANTOM Premium should change dynamically as you move the stylus around.

**Cycle Amps** This will simply turn the amplifiers off then on again repeatedly to test their functioning. You should hear the device clicking on and off.

**Test Forces** IMPORTANT: Hold onto the stylus when executing this test. Move the sliders with your mouse to generate forces which push against your hand. X controls force parallel to the table. Y controls force up and down. And Z controls force in and out.

**Box Test** Provides a box which you can feel with your PHANTOM Premium. The sides of the box should feel flat and the corners sharp.

**Quit** Quits the test application.

### General Support

Please go to [www.sensable.com/support-overview.htm](http://www.sensable.com/support-overview.htm) for a menu of additional support options and resources.



# Appendix G: Power Specifications

	<b>With Internal Auto-Switching Power Supply</b>
Output Current Rating	8.3 A
AC Input	100 ~120 VAC 200 ~ 240 VAC (auto-switching power supply)
Input Frequency	50/60 Hz
AC Current	5A / 115V, 2.5A / 230 V
Inrush Current	15A / 115V, 30A / 230 V

## G POWER SPECIFICATIONS

# Appendix H: Regulatory Notices

## FCC Notice (U.S. Only)

The PHANTOM® Premium model haptic devices are classified by the Federal Communications Commission (FCC) as Class B digital devices.

**Note:** 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.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules. The following information is provided on the device covered in this document in compliance with FCC regulations:

**Product Name:** PHANTOM Premium

**Model Numbers:** Model version(s) of Premium 1.05, 1.5, & 1.5 HF with and without Encoder Gimbal

**Company Name:** SensAble Technologies, Inc.

## NOTES

Any changes or modifications to the hardware not expressly approved by SensAble Technologies could void the user's authority to operate this equipment. This device is to be used with the SensAble-supplied power supply only. Replacement power supplies are available directly from SensAble Technologies.

### Canadian Requirements:

Canadian Department of Communications Radio Interference Regulations

These digital apparatus, the PHANTOM Premium haptic devices, do not exceed the Class B limits for radio-noise emissions from digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications.

Règlement sur le brouillage radioélectrique du ministère des Communications Cet appareil numérique, the PHANTOM Premium haptic device, respecte les limites de bruits radioélectriques visant les appareils numériques de classe B prescrites dans le Règlement sur le brouillage radioélectrique du ministère des Communications du Canada.

### European Requirements:

#### EN 55022 Statement

This is to certify that the SensAble Technologies PHANTOM Premium haptic devices are shielded against the generation of radio interference in accordance with the application of Council Directive 89/336/EEC, Article 4a. Conformity is declared by the application of EN 55022 Class B (CISPR 22).

**Warning:** This are Class B products. In a domestic environment, this product may cause radio interference, in which case, the user may be required to take appropriate measures.

**Achtung:** Dieses ist ein Gerät der Funkstörgrenzwertklasse B. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkstörungen auftreten, in welchen Fällen der Benutzer für entsprechende Gegenmaßnahmen verantwortlich ist.

**Attention:** Ceci est un produit de Classe B. Dans un environnement domestique, ce produit risque de créer des interférences radioélectriques, il appartiendra alors à l'utilisateur de prendre les mesures spécifiques appropriées.





# Appendix I: PHANTOM Premium Specifications

Product specifications are subject to change without notice.

	Premium 1.0	Premium 1.5	Premium 1.5 High Force	Premium 3.0	
<b>Workspace</b>	10 W x 7 H x 5 D inches 254 W x 178 H x 127 D mm	15 W x 10.5 H x 7.5 D inches 381 W x 267 H x 191 D mm		33 W x 23 H x 16 D 838 W x 584 H x 406 D mm	
<b>Footprint</b>	13 W x 10 D inches 330 W x 254 D mm	13 W x 10 D inches 330 W x 254 D mm		Detachable portion	8 W x 8 D inches 203 W x 203 D mm
				Electronics console (AMP box)	15 W x 20 D inches 381 W x 508 D mm
<b>Range of Motion</b>	Hand movement pivoting at wrist	Lower arm movement pivoting at elbow		Full arm movement pivoting at shoulder	
<b>Nominal Position Resolution</b>	860 dpi 0.03 mm	860 dpi 0.03 mm	3784 dpi 0.007mm	> 1000 dpi ~ 0.02 mm	
<b>Backdrive friction</b>	0.15 oz 0.04 N	0.15 oz 0.04 N	0.75 oz 0.2 N	0.75 oz 0.2 N	
<b>Maximum exertable force (nominal position)</b>	1.9 lbf 8.5 N	1.9 lbf 8.5 N	8.4 lbf 37.5 N	4.9 lbf 22 N	
<b>Continuous exertable force (nominal position)</b>	0.3 lbf 1.4 N	0.3 lbf 1.4 N	1.4 lbf 6.2 N	0.7 lbf 3 N	
<b>Stiffness</b>	20 lbf in <sup>-1</sup> 3.5 N mm <sup>-1</sup>	20 lbf in <sup>-1</sup> 3.5 N mm <sup>-1</sup>		5.7 lbf in <sup>-1</sup> 1 N mm <sup>-1</sup>	
<b>Inertia (apparent mass at tip) -without encoder gimbal</b>	< 0.17 lbm < 75 g	< 0.17 lbm < 75 g	< 0.33 lbm < 150 g	< 0.35 lbm < 159 g	

## I PHANTOM PREMIUM SPECIFICATIONS

	<b>Premium 1.0</b>	<b>Premium 1.5</b>	<b>Premium 1.5 High Force</b>	<b>Premium 3.0</b>
<b>Force Feedback</b>	x, y, z	x, y, z		x, y, z
<b>Position Sensing</b>	x, y, z (roll, pitch, yaw optional)	x, y, z (roll, pitch, yaw optional)	x, y, z (roll, pitch, yaw upon special request)	x, y, z (roll, pitch, yaw optional)
<b>Interface</b>	Parallel Port	Parallel Port		Parallel Port
<b>Supported Platforms</b>	Intel-based PCs	Intel-based PCs		Intel-based PCs
<b>GHOST® SDK Compatibility</b>	Yes	Yes	Upon special request	Yes
<b>OpenHaptics™ Toolkit Compatibility</b>	Yes	Yes		Yes