



phantom[®]
HAPTIC DEVICES

Desktop Device Guide

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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.

Questions or Comments

If you have any questions for our technical support staff, please contact us at support@sensable.com. You can also phone 1-888-SENSABL (U.S.A. only) or 1-781-939-7444 (International).

If you have any questions or comments about the documentation, please contact us at documentation@sensable.com.



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Preface

About this Guide

The Phantom Desktop® Device Guide describes the process of installing the required device drivers for your new Phantom Desktop haptic device and connecting the hardware device to your computer. You will also find information on how to use the device and other information about the device.

For the most current device information please visit the Sensable website at www.sensable.com.

We've worked extensively to ensure that the Phantom Desktop device and device drivers install and work smoothly. If you experience any problems in the installation or use of your device, please contact Sensable support (see inside cover for contact information).

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

Typographical Conventions

This guide uses the following typographical conventions:

Convention	Description	Example
<i>Italics</i>	First use of a new term; reference to another document or file.	A <i>Voxel</i> is...; see the <i>User Manual</i> .
Bold	Keywords, actual user input, or examples.	Click Ok .
Greater Than (>)	Indicates a menu pick, as in “select Options from the Tools menu”.	Tools>Options

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Getting Started

This guide covers the currently shipping Phantom Desktop haptic device. The information contained in this manual was current at the time of publication. Visit www.sensable.com for the latest information.

This chapter describes the following:

- The contents of the shipping box
- The Phantom Desktop haptice device
- System Requirements
- The proper handling of the Phantom Desktop haptic device

Contents of the Shipping Box

If you are purchasing a Phantom Desktop haptic device for the first time, in your shipping box you should find the following:

- **The Phantom Desktop haptice device:** The Phantom device uses high-fidelity force feedback to make it possible to touch and manipulate virtual objects.
- **The Phantom Desktop Device Guide:** Describes the process of connecting the haptic device as well as how to work with the device including proper handling, troubleshooting, and device specifications.
- **The Phantom Device Driver Installation Guide:** Describes the process of installing the device drivers.
- **Parallel Port Cable:** This cable is used to attach the computer's parallel port to the Phantom Desktop or, one unit to another. The cable is an IEEE 1284 EPP cable with a ferrite bead that provides an impedance at 100mhz of 199 ohms or greater.
- **Universal Power Supply:** The power supply can be used on any standard circuit, using the supplied power cord.
- **Power Cord:** The power cord connects the Universal Power Supply to the wall outlet.
- **Gelpad wrist rest:** To maximize comfort when using the Phantom Desktop haptice device.

If any items are missing, please call Sensable at 1-888-SENSABL.

The Phantom Desktop Haptic Device

The Phantom Desktop enhances productivity and efficiency by enabling the most intuitive human/computer interaction possible, the ability to solve problems by touch.

The Phantom Desktop system's high fidelity force feedback senses motion in 6 degrees of freedom providing the best, most realistic 3D Touch sensation for any application. You can feel the point of the stylus in all axes, and track its orientation (pitch, roll and yaw). The Phantom Desktop's portable design, compact footprint, and simple parallel port interface ensure quick installation and ease of use.

Features

- Dexterous Serial manipulator design
- Six degree-of-freedom positional sensing
- Portable design and compact footprint for workplace flexibility
- Compact workspace for ease-of-use
- Comfortable molded-rubber stylus with textured paint for long term use and secure grip
- Integrated momentary switch on the stylus for ease of use and end-user customization
- Automatic workspace coalibration based on integrated flags
- Multi-function indicator light
- Constructed of metal components and injection-molded plastics
- Wrist rest to maximize user comfort
- FCC, CE and RoHS Certified

System Requirements

The Phantom Desktop haptic device requires certain hardware and software components to be able to function properly. This section describes the requirements for operating the Phantom Desktop haptic device.

Note Visit www.sensable.com to get the latest and most complete system requirements for the Sensable application you will be using with the Phantom Desktop.

- An Intel® processor based personal computer (A minimum of 166 MHz Pentium® IV class processor is recommended) or select personal computer.
- IEEE 1284 EPP compliant on-board Parallel Port with a system driver capable of handling real-time device interrupts *or* Phantom Communication Converter connected to a FireWire Port *or* an approved Add-on Parallel Port Card (see sensable.com for specific product system requirements).
- Windows XP, Vista or Windows 7.
- A hard drive with 512 MB of disk space.

- The most current version of the Phantom Device driver (PDD). See the document *Installing Phantom Device Drivers* for specific PDD requirements.
- A Sensable supplied IEEE 1284 Parallel Cable.

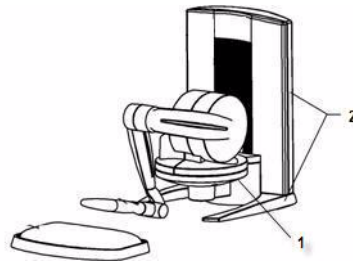
Proper Handling and Positioning of the Phantom Desktop Device

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

Handling the Phantom Desktop Device

Calibrating the device: The Phantom Desktop may need to be recalibrated from time to time, particularly if it has lost power. To calibrate the device, start with the stylus below the hub [1], then rotate the stylus up and all the way over to the left. The indicator light on the Phantom Desktop device will be lit a steady amber when the device is properly calibrated. Alternatively, you can use the Phantom Test application (**Start>All Programs>Sensable.**)

Lifting the device: Hold the covers and base to lift the Phantom Desktop device. The Phantom Desktop device is a sensitive piece of electronic equipment. Lift by the covers and support the base [2] when moving it. Lifting by any of the moving parts may affect the unit's performance and risks damaging the device. The device has a limited range of motion. Forcing the device past these limits risks damaging the device.



Position hands to securely fit the device.

Storing the stylus After the device is calibrated, the stylus may be left resting on the desk.

Protecting the device from damage It is best to place the unit firmly on the tabletop and away from edges to reduce the risk of damage to the device from direct unintentional impact.

Positioning the Phantom Desktop Device

The correct placement of the device will vary from one user to another. You may want to experiment to find a placement that feels right for you.

- The device should be positioned so that you are comfortable when working with it.
- You should not feel any strain on your wrist or forearm when working with the

1 GETTING STARTED

Proper Handling and Positioning of the Phantom Desktop Device

device.

- If you are left-handed, you may find it easier to work with the Desktop placed to the left of the keyboard.
- Remember to take breaks often to stretch your hands, wrists, and elbows.

Status Indicator Light

This light shows the status of the Phantom Desktop device as described in the following table:

COLOR	MEANING
Constant Amber	Active and properly calibrated
Blinking Green	Active, but out of calibration
Blinking Yellow	Just attached or powered on
Constant Orange	Stand-by mode

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Installing the Phantom Desktop Device

This chapter will provide system requirements and describe, step by step, how to install the Phantom Desktop haptic device. The installation is done in two steps.

- Install the software, the Phantom Device Driver, that allows your computer to communicate with the Phantom Desktop device.
- Connect the hardware, the Phantom Desktop device, to your computer and power source.

Installing the Phantom Device Drivers

The Phantom Desktop device communicates with the computer through the Parallel Port Cable. To enable this, you must install a software driver, called the Phantom Device Driver (PDD), to control the communication.

Specific instructions for installing the PDD on Windows XP, Vista and Windows 7 operating systems can be found in the document, *Phantom Device Driver Installation Guide*. For installation instructions for other operating systems, 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 system software. If you are unfamiliar with installing software or do not have administrator privileges, please have your System Administrator execute these steps for you.

Connecting the Phantom Desktop Device

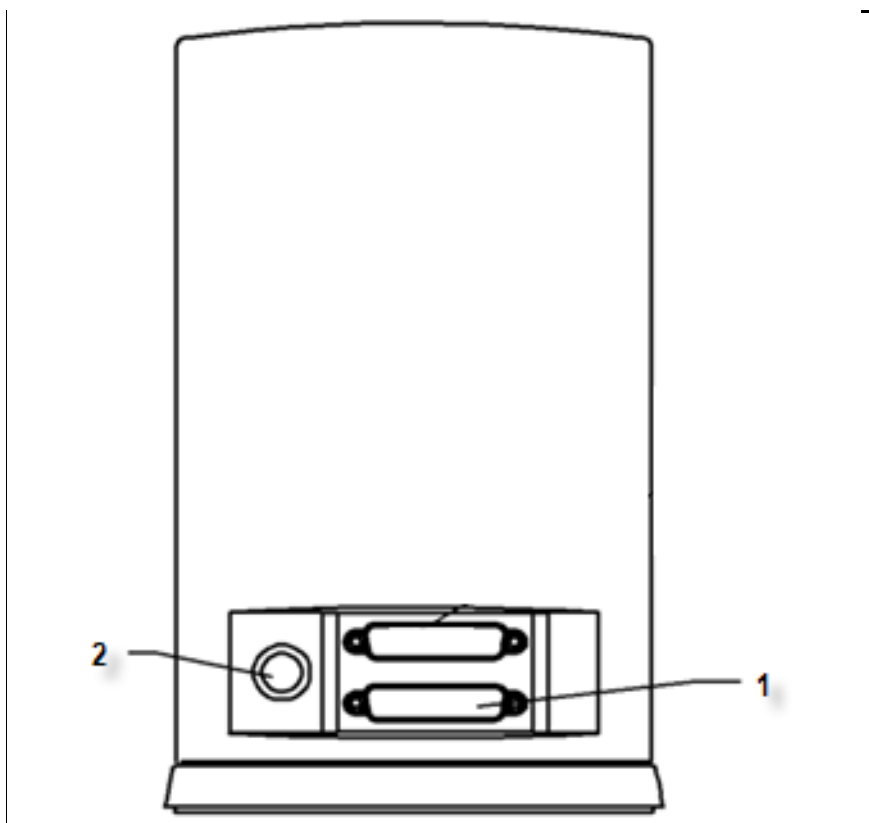
In this section you will setup the Phantom Desktop device and plug in all of the cables.

There are three ways to connect the Phantom Desktop device:

- 1 Connect the Parallel Cable from the device to the on-board Parallel Port.
- 2 Connect the Parallel Cable from the device to the Phantom Communication Converter and connect the FireWire from the PCC to your computer.
- 3 Connect the Parallel Cable from the device to an approved Add-on Parallel Card.

Note Exact appearance of your equipment may vary from that shown in the figures.

- 1 Shut down your computer after installing the PDD if you have not already done so.
- 2 Position the Phantom Desktop device in your workspace, using both hands to grasp the covers and base of the device. See “Proper Handling and Positioning of the Phantom Desktop” on page 1-3 for instructions on how to handle the device to reduce the risk of damage.
- 3 Connect the power supply as follows:
 - a With the computer still turned off, attach the male end of the supplied IEEE-1284 rated cable to the appropriate parallel port.



Connect the power cables to the back of the Desktop device.

- b Plug the female end of the cable to the parallel connector (1) of the Phantom Desktop.

- c Hook up the Power Supply (use only the supplied power supply with the Phantom Desktop device):
Plug the power cord into the power supply. Plug the power cord into an available outlet (for 110V the outlet must be rated for at least 2 Amps, for 220V: 1 Amp). The green status light on the power supply indicates that it is working correctly. Finally plug the power connector into the connector (2) on the back of Phantom Desktop device.
 - d Ensure that the Phantom Desktop Status Indicator Light is lit (it will either be blinking yellow or solid orange if working properly). If it is not, check all of the connections. If the problem persists, contact Sensable Technologies.
- 4 Turn on your computer.

IMPORTANT

Sensable Technologies uses only Parallel Port components that exceed the IEEE 1284 EPP implementation recommendations. Sensable is not responsible for any damage that may result from using 3rd party cables.

Run Phantom Test to Verify Setup and Calibrate

In this section you will run the Phantom Test application to confirm that the device is properly connected and installed.

- 1 Select **Start>All Programs>Sensable>Phantom Test**.
- 2 If the device is properly connected and installed, the Phantom Test application will open and you will be in select mode. Gently move the Phantom arm and the Phantom test application will synchronously display the movement in the display window.

If the device is not properly connected, you will receive the following:

“The Phantom device named ‘Default Phantom’
could not initialize properly.”

If you encounter this error message first check to see that the Desktop is the selected device in the Phantom Configuration tool (via the Control Panel). If you still encounter problems, reconnect the device and try again.

2 INSTALLING THE PHANTOM DESKTOP DEVICE

Run Phantom Test to Verify Setup and Calibrate

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Using the Phantom Desktop Device

This chapter will introduce you to working with the Phantom Desktop haptic device and the physical limits of the device's range of motion. It is important to understand these physical limitations so that you do not inadvertently damage the device by forcing it past its designed limits.

Working in 3D Space

We have become so accustomed to using a mouse to move around a computer monitor that we don't think twice as we move our hand around a desk to move the cursor on the computer screen. But there was a time not long ago when this seemingly simple task was not second nature; some even found it challenging and were often frustrated as they learned. If you are new to working in 3D digital space and haptics, working with the Phantom Desktop device may take a little getting used to. Understanding where objects are in 3D space may take some practice before you are able to move and manipulate objects with ease and certainty. Be patient with yourself.

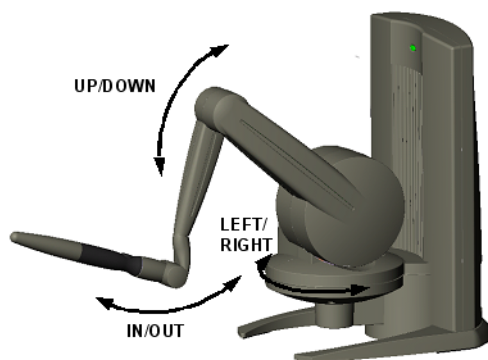
Physical Limits of the Device

The Phantom Desktop device has six degrees of motion provided by six axis points. All the degrees of motion have physical limits. When you reach one of these limits you will feel a sudden stop; this is the mechanical stop designed into the device. Forcing the device past any of these stops risks damaging the device.

Take some time to become more familiar with the physical limits of the Phantom Desktop before using the device by moving the device through its full range of motion at each axis point.

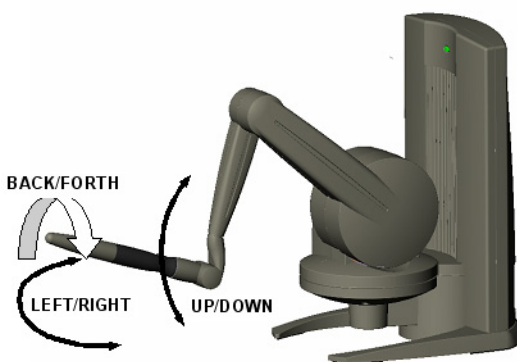
- 1 Grasp the rubber grip of the stylus as you would a pen, with the free end of the stylus (the eraser end of a pencil) pointing toward you and the point of the stylus (the end connected to the arm) pointing toward the unit. Using the following illustration as a guide, gently move the stylus in all directions to feel each mechanical stop.

- 2 Now, you will perform macro movements. That is, you will move the device at the "body", "shoulder", and "elbow" of the Phantom Desktop device.



Macro movements. Showing movement of the Phantom Desktop arm and the body.

- a Start with large-but gentle-movements. See the Figure above. Beginning at the top, move the arm of the device left/right. The body, sometimes referred to as the turret, of the Phantom Desktop device will pivot until it reaches a physical limit. Again, do not try to force the device past any of the mechanical stops.
- b Next, move the stylus up/down. The primary movement will happen in the shoulder of the Phantom Desktop device.
- c Next move it in/out with the primary movement happening in the elbow. When you reach a physical limit, you'll feel one of the device's mechanical stops. Don't force the device past any of these stops.



- 3 Next you perform micro movements further down the haptic device, moving the device at the stylus, as in the image above.
 - a Holding the stylus with one hand rotate left/right at the top of the hammerhead.
 - b Next pivot it up/down at the bottom of the hammerhead where it joins the stylus.
 - c Finally gently twist the stylus back/forth.

Now you should have an understanding of the range of motion of the Phantom Desktop device at each axis point and where its limits are.

Warning ALWAYS work with the connected end of the stylus pointing away from you. NEVER rotate the stylus with the point facing you.

3 USING THE PHANTOM DESKTOP DEVICE

Physical Limits of the Device

Appendix: Troubleshooting

This section provides tips for correcting some common problems encountered with the Phantom Desktop device. If after following these steps, you cannot resolve the problem, please contact customer support (see Appendix B:, "Customer Support").

#1 The Phantom Desktop light does not come on at all.

The light on the Phantom Desktop device should be on if it is receiving power. Check that the power supply is plugged into a working outlet (the light on the power supply should be green if it is). Then check that the connection between the power supply and the Phantom device is made correctly.

#2 The light on the Phantom Desktop device is orange.

This is not a problem. When the device is plugged in, but not currently being used by an application, it will be orange to let you know that it is receiving power.

#3 The light on the Phantom Desktop device is flashing yellow.

This is not a problem. This indicates that the power to the device and the parallel port have just been initially connected. Once you successfully run an application with the device, such as one of the provided demonstrations, the light should no longer be this color.

#4 When running a demonstration or application, the light on the Phantom Desktop flashes green.

This indicates that your Phantom Desktop may not be properly calibrated. This can happen if you unplug it. To re-calibrate the device, follow the steps for Running the Phantom Test, found in Chapter 2. If you are unable to calibrate the device using these steps, please contact Customer Support as explained in Appendix B.

#5 When I start the Phantom Test or the FreeForm application I hear clicking.

First confirm that your parallel port card is properly installed:

- Open **Control Panel>System** and select the Hardware tab.
- Select Device Manager.
- Expand the port settings and confirm that ITE887x is listed. If you are not using the supported PCI Parallel Port card, select your card from the list.
 - If no parallel port card is listed, it is not properly installed. Reinstall the card according to the manufacturers instructions.
 - If the card is listed, verify the hardware configuration settings.
- Right-click the parallel port listed (shown above as ITE887x PCI Parallel Port) and select Properties.
- Select the Resources tab.

Confirm that both I/O Range and IRQ resource types are present.

- If one or the other is not present, the Phantom device will be unable to communicate correctly leading to the clicking. Stop here and reinstall the PCI parallel port card.
- If both are present, select the Port Settings tab and confirm that the Filter Resource Method is set to "Use any interrupt assigned to the port". If this is not selected, change the setting and reboot your machine when prompted.

#6 When I start a demo I get an error.

This can happen if the device is not plugged in properly or is not configured properly. Execute the following steps, checking at each point for proper operation:

- Verify power supply - Check to make sure the Phantom Desktop device is plugged in properly. The light on the device will be lit (and possibly flashing) if power is being provided.
- Verify parallel port connection - Make sure that you have the parallel port cable plugged into the LOWER port on the Phantom Desktop device. Make sure you have the other end plugged into the parallel port on your computer.
- Verify matched settings between the Phantom Desktop device and computer:
 - From the Start menu, select **Settings>Control Panel**. Within the control panel window, select Phantom Configuration. You will be presented with a dialog box for configuring your device. Ensure that Phantom Desktop is chosen as the model. Check and write down the parallel port mode and base address (for example, "ECP" and "x378").
 - Restart your computer and prepare to enter the BIOS setup. (If you are unfamiliar with configuring a BIOS, get assistance from a system administrator or other computer professional).
 - Enter BIOS setup (how this is done varies by machine, but the key to press will usually be listed immediately upon the start of the re-boot sequence - usually F1, F2 or DEL. On some machines, you may have to turn the computer fully off and on again to reach the BIOS configuration utility).
 - While you are in the peripherals configuration page, check to see what alternate settings are available for the parallel port (for example, check to see if both ECP and EPP are available). If the device does not run with one setting you can try another using the steps below.
- If the device still does not run and you have more than one setting available in your BIOS setup (see "d" above), then re-enter the Phantom Configuration utility and set the port mode to one of the other modes available in your BIOS. Then, restart and re-enter the BIOS setup and set it to the same settings.

#7 I am able to start a demonstration application; but even though the light is solid green, the device behaves strangely when I move it around in a scene.

It is possible that there is a defect or a loose connection inside the Phantom Desktop device. DO NOT ATTEMPT TO OPEN THE DEVICE. Contact Sensable Customer Support. 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.

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

- 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. The stylus switch is ON when the user presses the button. The presence switch is ON when the user holds the rubber stylus handle. The picture of the Phantom Desktop 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. Z controls force in and out.
- Box Test - Provides a box which you can feel with your Phantom Desktop device. The sides of the box should feel flat and the corners sharp.
- Quit - Quits the test application.

Appendix: Customer Support

Warning DO NOT OPEN THE 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. There are no serviceable components in the Phantom Desktop device or power supply. Return to Sensable for servicing.

If you encounter any difficulties within your warranty period, you can obtain Technical Support through the three channels listed below. If you are out of warranty and do not have active maintenance, Technical Support is limited.

- If you purchased your Phantom Desktop device from a distributor, please contact them first.
- Sensable Technologies Customer Support can be reached via e-mail at 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: Regulatory Notices

FCC Notice (U.S. Only)

The Phantom Desktop® haptic device is classified by the Federal Communications Commission (FCC) as a Class B digital device.

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 Desktop

Model Number: 01352

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.

Use of an IEEE-1284 parallel port cable with a ferrite bead is required to comply with the Class B limits of Part 15 of the FCC rules. This cable is provided with the hardware; additional cables are available directly from Sensable Technologies.

Canadian Requirements:

Canadian Department of Communications Radio Interference Regulations

This digital apparatus, the Phantom Desktop haptic device, does 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 Desktop 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 Desktop haptic device is 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 is a Class B product. 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: 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, select **Settings>Control Panel>Phantom Configuration**. The Phantom Configuration window opens.
- 2 On the hardware tab, click **Add**.
- 3 Type a specific name to call that device, click **OK**.
- 4 From the Phantom model menu, select the **correct model**.
- 5 Click **OK**.

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. Then daisy chain two desktops using the two supplied parallel cables to a single EPP Port on your computer.

You must have created at least two Phantom configurations as described above. Then enable the "Connected via daisy chain" check box for the second Desktop in the chain to turn the dual configuration on.

Appendix: Phantom Desktop Re-Packaging Instructions

If you need to transport or ship the device, please follow these packaging guidelines to reduce the risk of damage to the device.

Important

Remember the Phantom Desktop device is a sensitive piece of electronic equipment and must be handled with care. Lifting the device by any of the moving parts may adversely affect the unit's performance and risks damaging the device. The Phantom Desktop device has a limited range of motion. Forcing the device past these limits risks damaging the device. If you have not already done so, please review "Proper Handling and Positioning of the Phantom Desktop" on page 1-3.

Shipping Checklist / Packing Materials:

You will need the following items to ship the device safely.

The packaging materials in which the device was originally shipped:

- 1 Medium shipping box
- 1 Set of foam inserts (cradles the device)
- Shipping Tray
- Packing tape

Packing the Device and Accessories

- If necessary, reassemble the box and arrange the foam inserts.
 - Fit the bottom foam insert into the bottom of the box.
- Orient the Phantom device to fit neatly inside the foam insert. You may need to grasp the Phantom device by the upper arm—the piece with the oblong cutout— in order to position it properly. DO NOT grab the stylus.
- Gently lower the Phantom device into the insert, while maintaining alignment of the Phantom arm to the cutout.

APPENDIX: PHANTOM DESKTOP RE-PACKAGING INSTRUCTIONS

- Ensure that the Phantom device is fully seated by pressing firmly on the Phantom Desktop label.
- Check to see that the Phantom arm is fully seated by carefully pressing on the elbow joint.
- Place the top half of foam insert over the Phantom device.
- Place the stylus, power supply, power cord, and Parallel Port cable into the Shipping Tray on the top of the foam insert.
- Place the Shipping Tray over the foam insert.
- Close the box and tape shut.

Appendix: Device Specifications

Product specifications are subject to change without notice.

Force Feedback Workspace	~ 6.4 W x 4.8 H x 4.8 D in	> 160 W x 120 H x 120 d mm
Footprint (physical area the base of the device occupies on a surface)	~ 5 5/8 W x 7 1/4 D in	~ 143 W x 184 D mm
Weight (device only)	6 lbs 5 oz	~2.86 kg
Range of Motion	Hand movement pivoting at wrist	
Nominal Position Resolution	> 1100 dpi	~0.023 mm
Backdrive Friction	< 0.23 oz	< 0.06 N
Maximum Exertable Force (at nominal orthogonal arms position)	1.8 lbf	7.9 N
Continuous Exertable Force (24 hrs)	> 0.4 lbf	> 1.75 N
Stiffness	X axis > 10.8 lbs./in Y axis > 13.6 lbs./in Z axis > 8.6 lbs./in	X axis > 1.86 N/ mm Y axis > 2.35 N/mm Z axis > 1.48 N/mm
Inertia (apparent mass at tip)	~ 0.101 lbm	~ 45 g
Force Feedback	x, y, z	
Position Sensing	x, y, z (digital encoders)	
Stylus gimbal	Pitch, roll, yaw (\pm 3% linearity potentiometers)	
Interface	Parallel Port	
Supported platforms	Intel or AMD-based PCs	
OpenHaptics® SDK compatibility?	Yes	

* Please visit the Support and Resources section of our website for more information (www.sensable.com/support-overview.htm).

