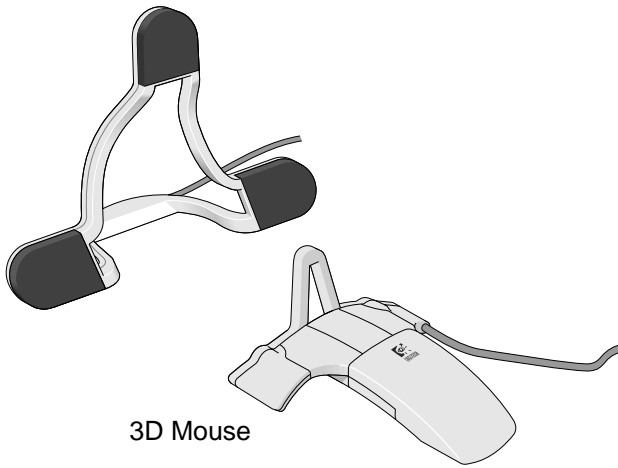# LOGITECH

3D MOUSE & HEAD TRACKER
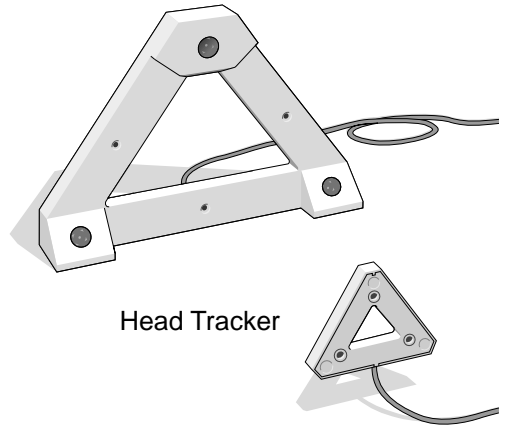
LOGITECH

TECHNICAL REFERENCE MANUAL

3D Mouse
& Head Tracker
Techical Reference Manuel

3D Mouse

Head Tracker

LOGITECH

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• Increase the separation between the equipment and the 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.

The user may find the following booklet prepared by the Federal Communications Commission
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Table of Contents

Preface

This manual describes the components and operation of the 3D Mouse and Head Tracker systems.

The information in this manual is for technical reference. It is intended for OEMs (Original Equipment Manufacturers), VARs (Value Added Retailers), and software and hardware developers who integrate the 3D Mouse and Head Tracker technology into their products.

Knowledge in the following areas would be beneficial, but is not required:

- the C programming language, and the ability to adapt the code provided in this manual and associated software to your application-specific programming language
- device driver development
- RS-232 (serial) communication
- 3D graphics programming

This manual is organized as follows:

Chapter 1, Introduction. This chapter introduces the 3D Mouse and Head Tracker system features and components.

Chapter 2, Installation and Setup. This chapter describes how to install and setup the 3D Mouse and Head Tracker components. It also describes how to run TEST3D program.

Chapter 3, Component Description. This chapter provides a detailed description of how each component works.

Chapter 4, Using Multiple Control Units. This chapter describes when you need to use multiple control units, how to connect them, and which components to connect to them.

Chapter 5, System Operation. This chapter describes how the 3D Mouse and Head Tracker systems communicate position and orientation data to the host computer.

Chapter 6, Application Programming Interface. This chapter defines the 2D and 3D mode command set.

Chapter 7, Questions & Answers. This chapter includes commonly asked questions about the 3D Mouse and Head Tracker systems and recommended answers.

Appendix A, 3D Mouse & Head Tracker Specifications. This appendix lists the 3D Mouse and Head Tracker hardware specifications.

Appendix B, Creating a Custom Receiver. This appendix provides information to help you create a custom 3D Mouse receiver.

1

Introduction

This chapter summarizes the 3D Mouse and Head Tracker system features. It also lists the basic system components, as well as additional components you can add for more sophisticated system configurations.

System Features

The award-winning, Logitech 3D Mouse and Head Tracker allow you to input three-dimensional, spatial information into a host computer, from IBM PC compatibles to high-end graphics workstations. These systems are designed for sophisticated software and hardware applications, including CAD/CAM, computer animation, computer modeling, robotic control, 3D graphics, and virtual reality workstations.

The 3D Mouse and Head Tracker are easy to setup and use. The stationary transmitter emits ultrasonic signals that track the movement of the receiver. The receiver, which you move about three-dimensionally within the active area in front of the transmitter, receives the ultrasonic signals and relays them back to the control unit. The control unit converts the signals into position and orientation data that can be processed by the host computer.

Configuration of the 3D Mouse and Head Tracker components is very flexible. You can use just the 3D Mouse or the Head Tracker. You can use both the 3D Mouse and the Head Tracker receivers at the same time. Or, you can integrate the 3D Mouse and Head Tracker components into your own custom system. The configuration is up to your needs.

The 3D Mouse operates in both 3D and 2D modes. The 3D mode reports three-dimensional and rotational positions. The 2D mode reports two dimensional positions just like an ordinary, conventional mouse. It is 100% compatible with Logitech and Microsoft pointing devices.

The 3D Mouse and Head Tracker allow you to incorporate voice recognition and sound applications. The control unit provides an Audio-Out connector for you to connect an audio processing device and input sound through the receiver's top microphone.

Basic System Components

Before you install the 3D Mouse or Head Tracker, take a moment to familiarize yourself with the associated components. The product comes with either the 3D Mouse or Head Tracker components. For more detailed information about how these components work, see Chapter 3, "Component Description."

Basic 3D Mouse Components

The basic 3D Mouse system includes the components shown in Figure 1-1.
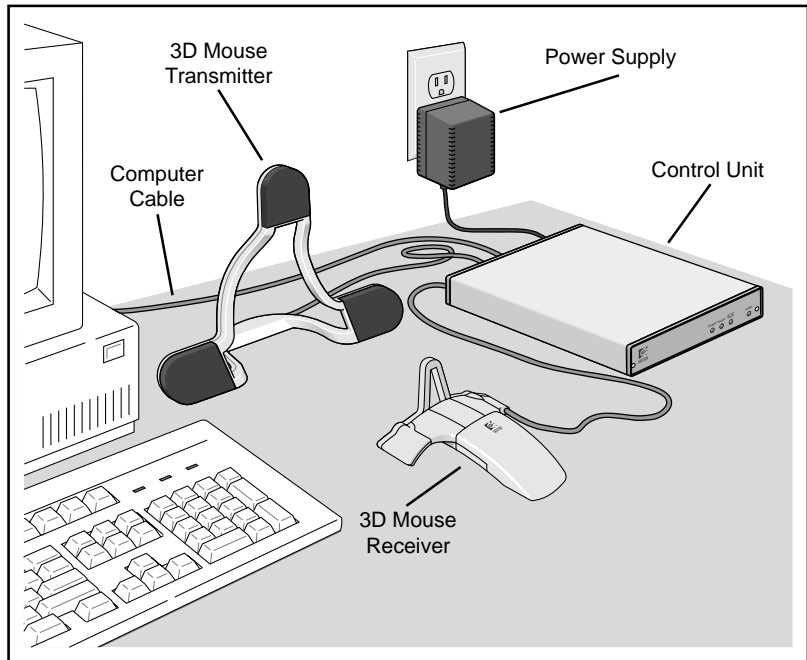

Figure 1-1. 3D Mouse Components

Basic Head Tracker Components

The basic Head Tracker system includes a transmitter, receiver, control unit, power supply, and computer cable. Figure 1-2 shows the transmitter and receiver.

Head Tracker
Transmitter

Head Tracker
Receiver
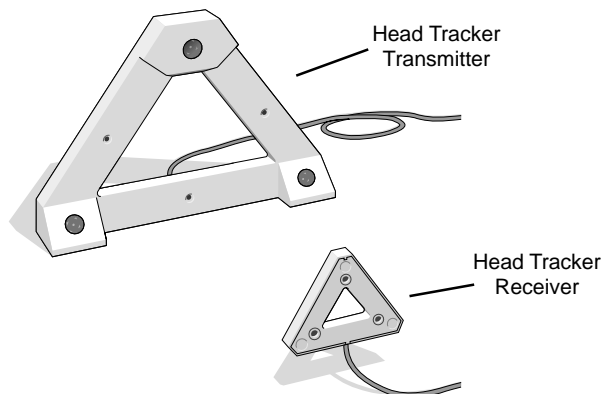
Figure 1-2. Head Tracker Transmitter and Receiver

Additional Components and Features

Multiple Control Units. You can connect up to four control units together for simultaneous head and hand tracking (tracking with up to four receivers and one transmitter). For more information about using multiple control units, see Chapter 4.

Custom Devices. You can create a custom 3D Mouse receiver. Instructions and an electrical schematic appear in Appendix B. You can also create head tracking devices that incorporate the Head Tracker transmitter and receiver. These components include screw holes so you can mount them (see "Arranging the Head Tracker Components" in Chapter 2).

Audio Processing Device Feature. You can add your own audio processing device to the 3D Mouse system for 3D applications with voice recognition and sound. Connect the audio processing device to the Audio Out connector on the control unit's rear panel. Input sound through the 3D Mouse or Head Tracker receiver's top microphone.

2

Installation and Setup

This chapter describes how to setup and arrange the basic 3D Mouse and Head Tracker components. It also describes how to run the TEST3D program so you can ensure that the components work properly.

Connecting the Components

The transmitter, receiver, audio, computer, and power supply cables plug into the rear panel of the control unit. Figure 2-1 shows the connectors on the control unit's rear panel. The circled letters correspond with the components and the order you can connect them.
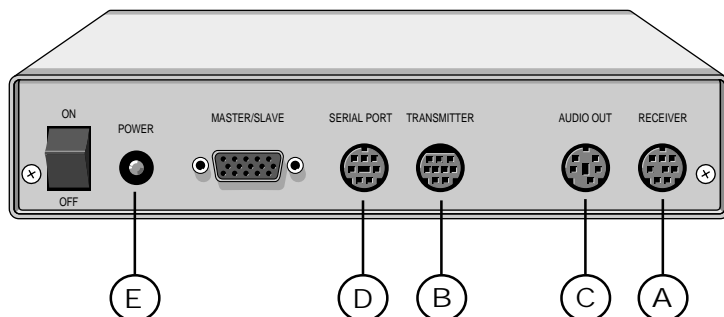
Figure 2-1. Control Unit Back Panel Connectors

Follow these steps to connect the basic 3D Mouse or Head Tracker components:

1. **Turn off your host computer.**

2. **Ensure that the control unit's On/Off switch is in the OFF position.** We recommend that you do not turn on the control unit until you have finished connecting the components.

3. **Plug the receiver cable into the Receiver connector on the rear panel of the control unit (see A in Figure 2-1).** The arrow on the cable should appear on top (see Figure 2-2).
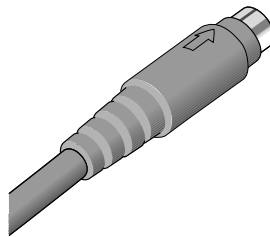
Figure 2-2. Positioning the Cable Arrow

4. **Plug the transmitter cable into the Transmitter connector (see B in Figure 2-1).**

5. **(Optional) plug the audio cable into the Audio Out connector (see C in Figure 2-1).**

6. **Plug the rounded end of the computer cable into the Serial Port connector (see D in Figure 2-1).**

7. **Connect the computer cable's 9-pin plug into an available serial (COM) port in the back of your host computer.** If your computer has a 25-pin serial port connector, attach the 9- to 25-pin adapter provided. Remember which serial port you use, because you will have to indicate it when you run the TEST3D program.

8. **Plug the rounded end of the power supply cable into the Power Supply connector (see E in Figure 2-1).**

9. **Plug the power supply into an AC outlet or power strip.**

10. **Turn on your host computer.**

11. **Turn on the control unit. Flip the On/Off switch to the ON position.** The red Power LED on the front panel of the control unit should light.

Arranging the Components

For optimum 3D Mouse and Head Tracker performance, arrange the components as described in the following sections.

Arranging the 3D Mouse Components

Typically, arrange the 3D Mouse components as shown in Figure 1-1 in Chapter 1. Ensure that there is sufficient cable length before connecting the components. Place the transmitter so that it faces the 3D Mouse receiver. Do not place any object between the transmitter and receiver. Make sure that the plane of the 3D Mouse transmitter is parallel to the plane of the host computer monitor.

Work in a normal office environment. Do not work near equipment that emits loud noises or ultrasonic frequencies. Also, ensure that there are no reflective surfaces within 12 inches of the top and sides of the transmitter. If there is interference, relocate your system or create a sound-absorbing barrier.

In 3D mode, ensure that there is enough space to move and rotate the receiver in a direct line of communication with the transmitter (see Figure 2-3)
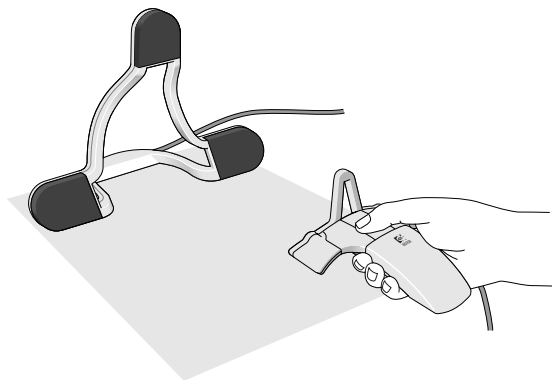

Figure 2-3. Holding 3D Mouse in Front of the Transmitter

In 2D mode, ensure that there is enough space on your desk to move the receiver freely in a direct line of communication with the transmitter.

Arranging the Head Tracker Components

Arrange the Head Tracker components as discussed in the previous section "Arranging the 3D Mouse Components." However, when using the Head Tracker, the transmitter does not have to be parallel with the plane of the host computer's monitor.

Custom Head Tracker Arrangements

The Head Tracker transmitter and receiver have screw holes so you can mount them onto almost any custom device you design for your specific needs. This section shows two custom devices designed by two hardware developers that incorporate the Head Tracker components.

The first device, which appears in Figure 2-4, shows a head-mounted image display designed by the Virtual Research company. The Head Tracker receiver is mounted onto the top of the Virtual Research™ helmet. The transmitter must be mounted overhead, within range, and in a direct line of communication with the receiver. The image on the display adjusts to movements of the user's head.
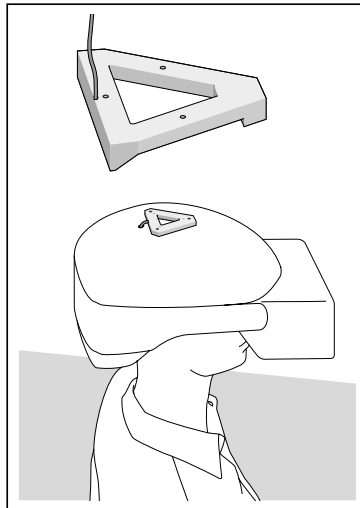
Figure 2-4. Head Tracker Incorporated in Head-Mounted Display

The second device, which appears in Figure 2-5, shows a user wearing virtual reality, Stereographics® Crystal Eyes® VR glasses and the 3D Mouse transmitter. These glasses, designed by the StereoGraphics® company, function as a receiver-three microphones are imbedded in the glasses frame.

The Crystal Eyes® VR glasses allow the user to see a virtual, holographic image that appears to float in front of the host computer's monitor. As the user moves his/her head, the holographic image adjusts to the user's head movements.

Figure 2-5. Custom Stereographics® Glasses with Microphones

Running the TEST3D Program

After you connect and arrange the 3D Mouse or Head Tracker components, we recommend that you run the TEST3D Program, provided on your program diskette. The TEST3D Program indicates whether the components work properly.

To run the TEST3D Program, you must have an IBM PC or compatible computer with the following:

• 386 or above

• Coprocessor

• VGA graphics adapter

• 3 ½-inch disk drive

• 2 MB (megabytes) of RAM

• DOS 5.0

Also to run the TEST3D Program, you must first view the README.TXT information file, then follow the instructions in the "TEST3D User Documentation" section of the file.

The README.TXT file also provides error messages that the TEST3D program generates and suggests corrective action.

3

Component Description

This chapter provides a detailed reference for how the 3D Mouse and Head Tracker components work.

3D Mouse Transmitter

The 3D Mouse transmitter includes three speakers that send 23 KHz ultrasonic signals to the receiver (see Figure 3-1; the dark pads cover the speakers). These ultrasonic signals track the receiver's position and orientation.

The 3D Mouse transmitter communicates with either the 3D Mouse or Head Tracker receiver. The ultrasonic sound radiates from the center of each speaker in a 100 degree spherical cone. Where these three cones intersect is the active area of communication, see "Active Area" in Chapter 5. There should be no obstruction within the active area.

The transmitter's cable connects to the control unit via the Transmitter connector. If you are using multiple control units, the transmitter connects to the "Master" control unit only (see "Multiple Control Unit Components" in Chapter 4).
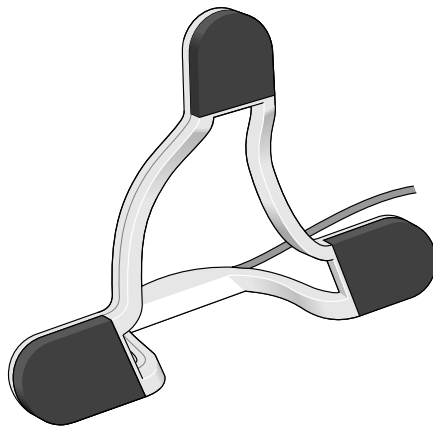
Figure 3-1. 3D Mouse Transmitter

3D Mouse Receiver

The 3D Mouse receiver has a triangle of microphones at the front end of the unit (see Figure 3-2; the three dark spots are the microphones). These microphones sample the ultrasonic signals from the transmitter at a rate of up to 50 times per second. The receiver relays these signals regarding its position and orientation to the control unit.
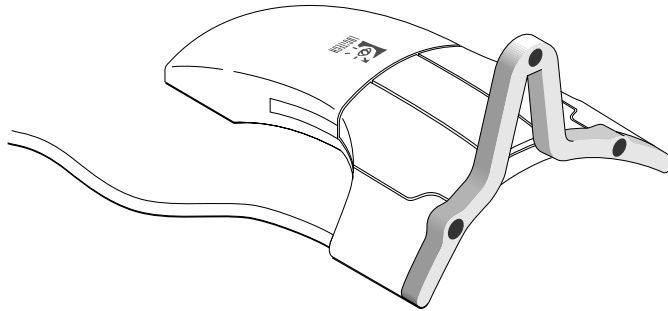
Figure 3-2. 3D Mouse Microphones

The 3D Mouse receiver samples the transmitter's ultrasonic signals within the active area of communication, see "Active Area" in Chapter 5. There should be no obstruction between the receiver and the transmitter within this active area.

The top microphone supports audio input.

The receiver's cable connects to the control unit via a Receiver connector.

The 3D Mouse receiver includes five, application-specific buttons: three top buttons and two side Suspend buttons (see Figure 3-3). The top buttons function like conventional Logitech mouse buttons-left, middle, and right. You can use these buttons in both 2D and 3D modes.

Three top buttons
(left, middle, right)

Suspend button
(right hand)

Suspend button
(right hand)
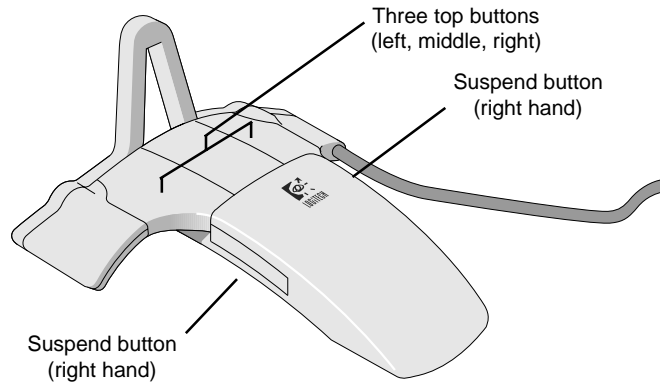
Figure 3-3. 3D Mouse Receiver Buttons

The 3D Mouse receiver is ergonomically designed to fit comfortably in the palm of either your right or left hand. The Suspend buttons function identically. The left Suspend button is for right-handed user. The right Suspend button is for left-handed users.

In 2D mode when you move the 3D Mouse on your desktop, the Suspend buttons allow you to move the 3D Mouse without reporting its position to the host computer. This function is the same as picking up a conventional mouse from the desktop to reposition it without moving the screen cursor. In 3D mode, you can assign application-specific functions to the Suspend buttons.

13

Hold the 3D Mouse receiver in a way that feels most comfortable to you. Figures 3-4 and 3-5 show two ways of holding the mouse in 3D mode.
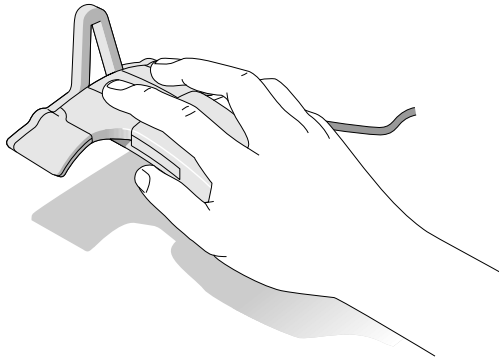
Figure 3-4. Holding the 3D Mouse Receiverin 3D Mode

Hold the receiver up off the desktop and move and rotate it within the active area in front of the transmitter.
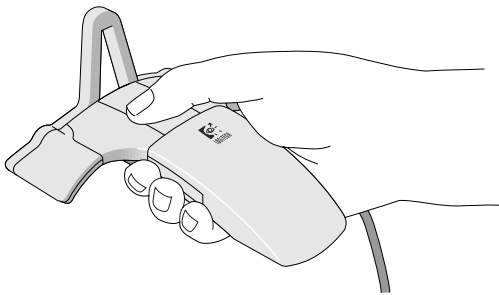
Figure 3-5. 3D Mouse Receiver Buttons

In 2D mode, you can hold the 3D Mouse receiver in a way that feels most comfortable to you. One way of the holding the mouse is illustrated in Figure 3-6. Move the mouse around on the desktop within the active area of the transmitter.
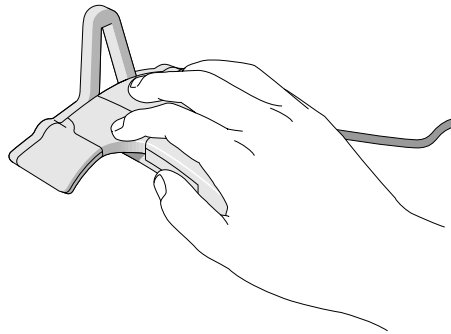
Figure 3-6. Holding the 3D Mouse Receiverin 2D Mode

Head Tracker Transmitter

The Head Tracker transmitter functions like the 3D Mouse transmitter discussed earlier in this chapter (see Figure 3-7; the three large circles are the speakers).
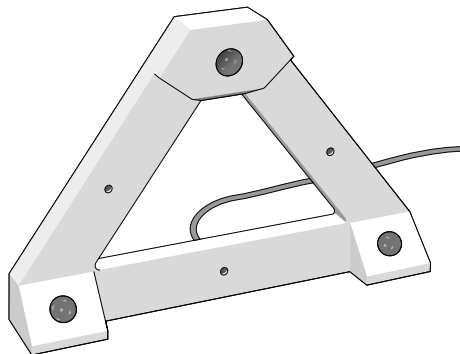
Figure 3-7. Head Tracker Transmitter

However, the Head Tracker transmitter is designed so you can mount it overhead. It includes three screw holes that allow you to mount it securely in a direct line of communication to the receiver. See "Arranging the Head Tracker Components" in Chapter 2.

Head Tracker Receiver

The Head Tracker receiver functions like the 3D Mouse receiver discussed earlier in this chapter (see Figure 3-8; the three large circles are the microphones).
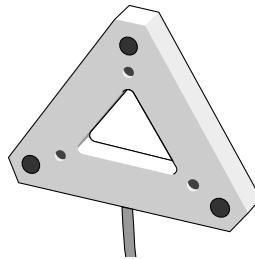
Figure 3-8. Head Tracker Receiver

However, the Head Tracker receiver is designed so you can mount it to your custom head tracking devices. Therefore, it has no buttons. Three screw holes allow you to mount it securely onto custom devices (see "Arranging the Head Tracker Components" in Chapter 2).

Control Unit

The control unit is the heart of the 3D Mouse and Head Tracker systems. It contains a microprocessor, interface circuitry, and firmware that provides the functions of the system.

Warning   The control unit is fragile and cannot withstand being dropped nor rough treatment.

The control unit decodes signals from the receiver and computes the receiver's position and orientation (rotation) about these coordinates (see Chapter 5, "System Operation"). In addition, the control unit

determines the status of all of the mouse buttons. It then reports this data to the host computer via a serial communication link.

Figure 3-9 shows the control unit's front panel. This panel includes four LED's. The Power LED turns red when you turn on the control unit. The Transmit LED turns green each time the control unit sends a report to the host computer. During high-speed transmissions, such as stream mode, the Transmit LED turns on and off so quickly that it may appear dim. The Receive LED turns green when the control unit receives a command from the host computer. The Out of Range LED turns green when you move the receiver out of the active area of transmission or exceed the tracking speed (see Chapter 5, "System Operation").

Figure 3-9. Control Unit Front Panel

Figure 3-10 shows the control unit's rear panel. This panel provides connectors for all of the system components (see Chapt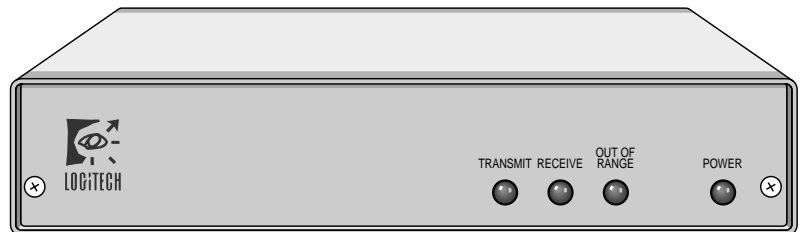er 2 for instructions for how to connect the components to the control unit). The rear panel also includes the On/Off switch
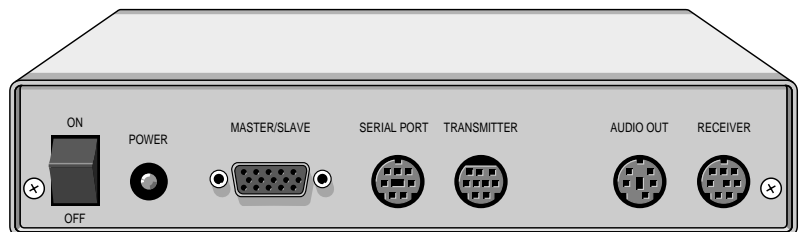

Figure 3-10. Control Unit Rear Panel

Computer Cable

The 6-foot, EIA RS-232C computer cable connects the control unit to the host computer. Its 7-pin, mini-DIN end plugs into the control unit's rear panel. Its 9-pin, D-sub end plugs into the computer's serial port. (Pin assignments for the computer cable are listed in Appendix A.) If the 9-pin plug doesn't fit your computer's serial port, use the 9- to 25-pin adapter.

The computer cable provides data transmission rates of 1200 bps in 2D mode and 19,200 bps in 3D mode at full duplex, with no echo.

Power Supply

The external power supply delivers DC power to the system via the control unit. The power supply plugs into a 115-volt wall socket or a power strip. The barrel end of the power supply cable plugs into the Power connector in the control unit's rear panel. The system also supports an optional 220V power supply.

Master/Slave Cable

The Master/Slave cable, which plugs into the control unit's Master/Slave connector, connects up to four control units together. One of the cable's four plugs is labeled "Master"; the other plugs are labeled "Slave." Tighten each plug's screws to connect the Master/Slave cable securely to each control unit connector.

Audio Device (Optional)

You can connect your own audio processing device to the control unit's Audio Out connector. An audio processing device allows you to incorporate sound into 3D applications. (See Table A-1 in Appendix A for the Audio Out pin assignments and signal names.)

Audio received by the top microphone of the receiver is amplified and routed through the LINE_OUT pin of the Audio Out connector. The EN_VOICE pin of the Audio Out connector is high when you press the Suspend button and low when you release it. The EN_VOICE pin provides support for "Push-to-Talk" applications.

4

Using Multiple Control Units

You can include up to four control units in a 3D Mouse and/or Head Tracker setup. This arrangement is called "Master/Slave."

There are several sophisticated situations when you need more than one control unit:

- to allow one person to perform head and hand tracking at the same time on one monitor
- to allow several people to perform head or hand tracking at the same time
- to allow several people to work together on one project in their own virtual space

This chapter describes the components that are necessary in a multiple-control unit setup, and how to connect the control units.

Multiple Control Unit Components

Figure 4-1 shows a block diagram of the components needed in a Master/Slave control unit arrangement. Here, one transmitter emits ultrasonic signals to each receiver and connects to the Master control unit. A receiver connects to each control unit and samples the transmitter's ultrasonic signals. You must connect a power supply to each control unit. Connect each control unit together in a daisy chain using a Master/Slave cable. Finally, connect each control unit to the host computer's serial ports.
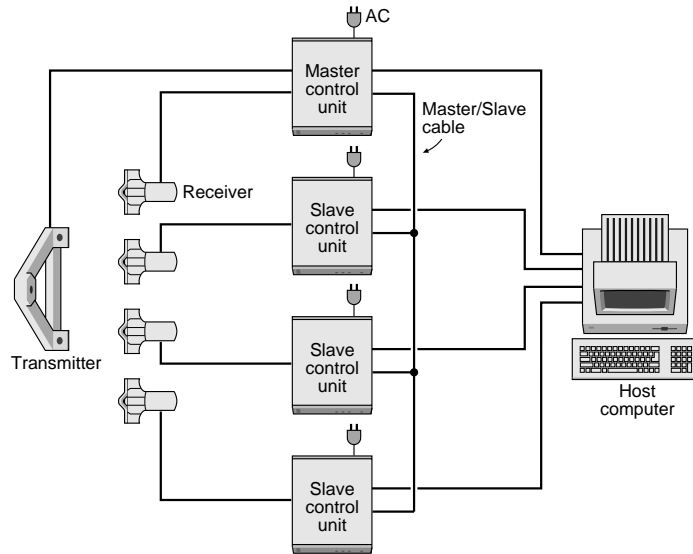
Figure 4-1. Multiple Control Unit

Connecting Multiple Control Units

Follow these steps to connect multiple control units:

1. **Stack the control units, one on top of each other.** You can include up to four control units.

2. **Ensure that the On/Off switch on each control unit's rear panel is in the Off position.**

3. **Designate the Master control unit.** It can be on the top or bottom of the stack. The other control units are called "Slave."

4. Connect each control unit together using the Master/Slave cable shown in Figure 4-2. Plug the cable into the Master/Slave connector on each control unit's rear panel. Plug the "Master" plug into the control unit that you've designated the Master control unit. Plug the "Slave" connectors into the remaining control units.
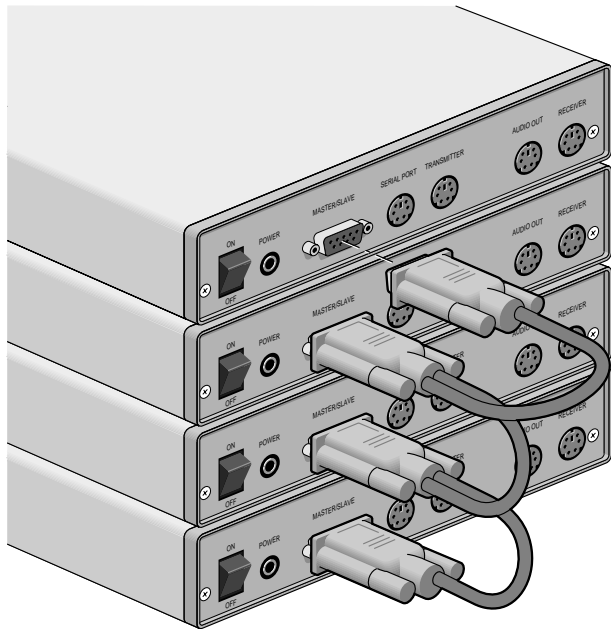
Figure 3-10. Control Unit Rear Panel

Connecting Components to Multiple Control Units

Follow these steps to connect components to multiple control units:

1. **Connect the transmitter to the "Master" control unit only.** If you connect the transmitter to a "Slave control unit, the system will not work. Connect the transmitter's plug into the Transmitter connector on the "Master" control unit's rear panel.

2. **Connect receivers to each control unit.** Connect a receiver plug into each control unit's Receiver connector.

3. **Connect a power supply cable to each control unit.** Connect the plug end of the power supply cable into each control unit's Power connector.

4. **Connect a computer cable to each control unit.** Connect the rounded plug end of each computer cable into each control unit's Serial connector.

5. **Turn off your host computer.**

6. **Connect each computer cable's 9-pin plug into a serial (COM) port in the back of the host computer.** If your computer has a 25-pin serial port connector, attach the 9- to 25-pin adapters provided. Remember which serial ports you use, because you will have to indicate them when you run the TEST3D program (for IBM PCs only).

7. **Turn on your host computer.**

8. **Turn on each control unit.** Flip each On/Off switch to the ON position. The red Power LED on the front panels of each control unit should light.

5

System Operation

The 3D Mouse and Head Tracker systems operate as follows: the transmitter emits ultrasonic signals. The control unit, via the receiver, detects these signals and derives receiver position and orientation data. The control unit reports this data and 3D Mouse button activity to the host computer.

This chapter describes the following:

- position and orientation data
- the active area of operation of the 3D Mouse and Head Tracker systems in both 2D and 3D modes
- the reporting modes the control unit provides in both 2D and 3D

3D Mode

In 3D mode, you can move the 3D Mouse or Head Tracker receiver three-dimensionally along three axes-X, Y, Z-and rotate it about these axes. The control unit derives the receiver's position and orientation and reports this data to the host computer.

Coordinate System

In 3D mode, the 3D Mouse and Head Tracker systems use a rectangular, Cartesian coordinate system to report the relationship between the receiver and the transmitter-the receiver's position and orientation.

Figure 5-1 shows the positive, three-dimensional direction of receiver movement-the X, Y, and Z axes. It also shows the positive rotation about these axes. Negative movement is in the direction opposite each arrow.
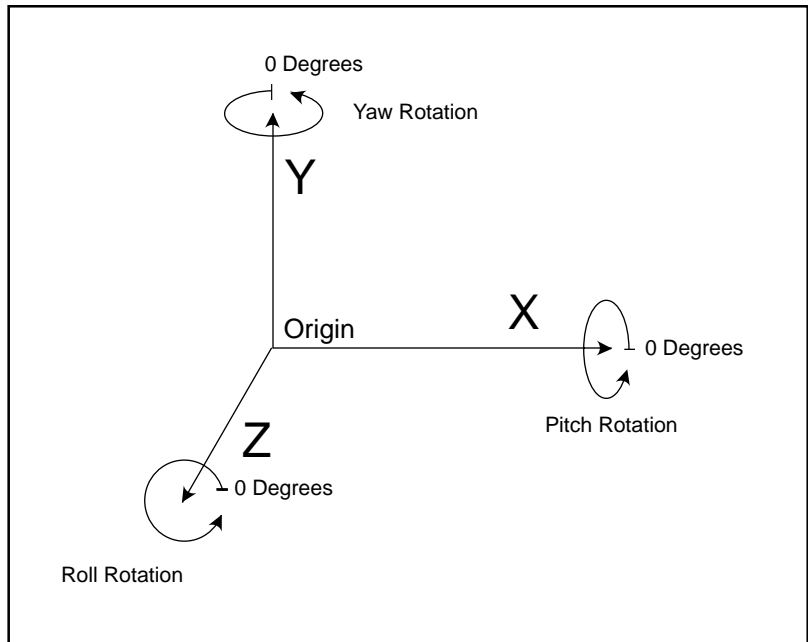
Figure 5-1. Three-Dimensional Axes and Rotation

Right-Hand Rules

The 3D Mouse and Head Tracker systems use two right-hand rules to help you determine position and orientation. The first right-hand rule allows you to hold your thumb, index finger, and middle finger of the right hand at right angles to each other to indicate the positive direction of the X, Y, and Z axes (see Figure 5-2).
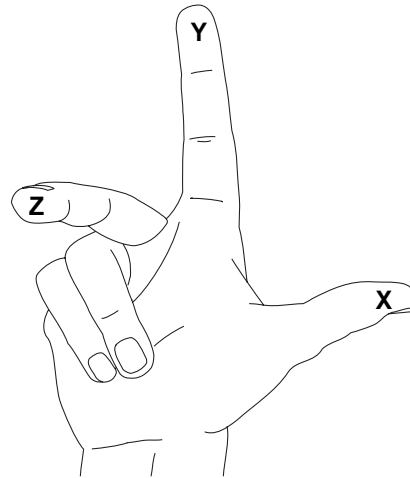
Figure 5-3. Right-Hand Rule Showing the X, Y, Z Axis

The second right-hand rule allows you to point your thumb in the positive direction of any axis and to curl your four fingers to represent positive rotation about that axis. In Figure 5-3, the thumb is pointed along the positive X axis, and the four fingers curl in the direction of positive rotation about that axis.

Positive direction of rotation about the X axis
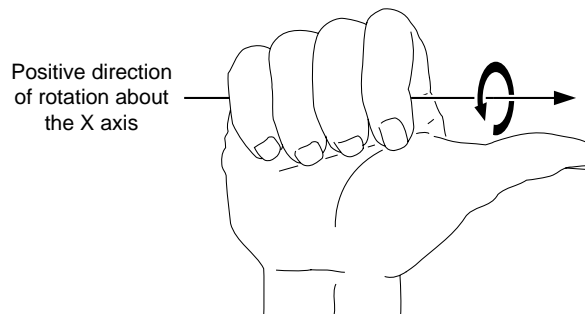
Figure 5-3. Right-Hand Rule Showing Rotation About the X Axis

Origin Points and Reference Axes

The positional and orientation data generated by the control unit are based on the 3D origin points and reference axes. In Figure 5-4, the transmitter's origin point and reference axes are defined by the following:

• X_T is an imaginary reference axis that passes through the center of the transmitter's lower left speaker and through the center of the transmitter's lower right speaker. (Only the positive direction of this is shown in Figure 5-4.)

• Y_T is an imaginary reference axis passing through the center of the transmitter's top speaker and is perpendicular to X_T.

• Z_T is an imaginary reference axis perpendicular to both X_T and Y_T.

• The transmitter's origin is the point where X_T, Y_T, and Z_T intersect.

Also in Figure 5-4, the receiver's origin point and reference axes are defined by the following:

• X_R is an imaginary reference axis passing through the center of the receiver's lower left microphone and through the center of the receiver's lower right microphone. (Only the positive direction of this axis is shown in Figure 5-4.)

• Y_R is an imaginary reference axis passing through the center of the receiver's top microphone and is perpendicular to X_R.

• Z_R is an imaginary reference axis perpendicular to both X_R and Y_R.

• The receiver's origin is the point where X_R, Y_R, and Z_R intersect.

Note   The transmitter's and receiver's origin points and reference axes described above also apply to the 3D Mouse transmitter and receiver.
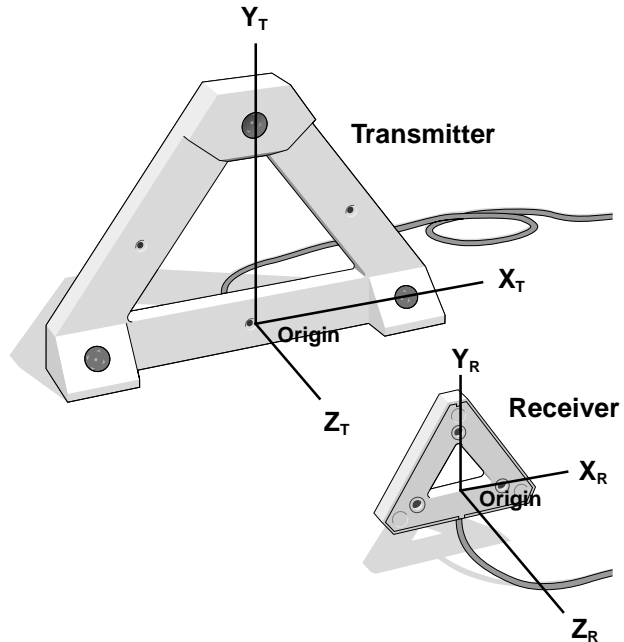
Figure 5-4. Transmitter and Receiver Origin Points and Reference Axes

Positional X, Y, Z Data

Positional data is the distance between the transmitter's and receiver's origin points.

X Data. This is the distance the receiver's origin point is to the left or right (along the X_T axis) of the transmitter's origin point (see Figure 5-4).

Y Data. This is the distance the receiver's origin point is above or below (along the Y_T axis) the transmitter's origin point-minus a 12-inch offset (see Figure 5-4). When the receiver is sitting on the desktop level with the base of the transmitter, the Y data will be approximately a negative 12 inches.

Z Data. This is the distance the receiver's origin point is away (along the Z_T axis) from the transmitter's origin point-minus an 18-inch offset (see Figure 5-4). When the receiver is 6 inches away from the transmitter the Z axis, the Z data will be approximately a negative 12 inches.

Orientation Data

Orientation describes the rotation of the receiver with respect to the transmitter. The orientation is described using the aeronautical terms: Pitch, Yaw, and Roll.

Pitch. Pitch orientation is positive or negative rotation about the receiver's X axis. Figure 5-5 shows positive Pitch rotation.

Figure 5-5. Positive Pitch Rotation

Yaw. Yaw orientation is positive or negative rotation about the receiver's Y axis. Figure 5-6 shows positive Yaw rotation.

Figure 5-6. Positive Yaw Rotation

Roll. Roll orientation is positive or negative rotation about the receiver's Z axis. Figure 5-7 shows positive Roll rotation.
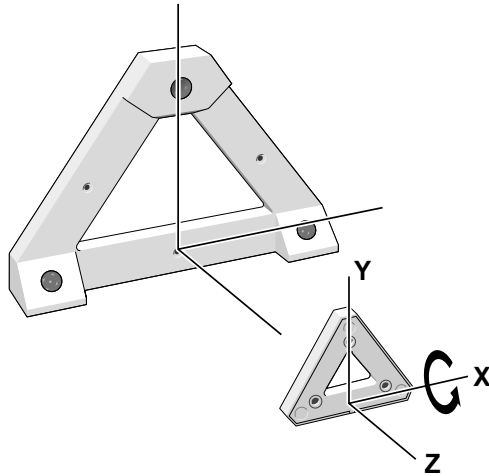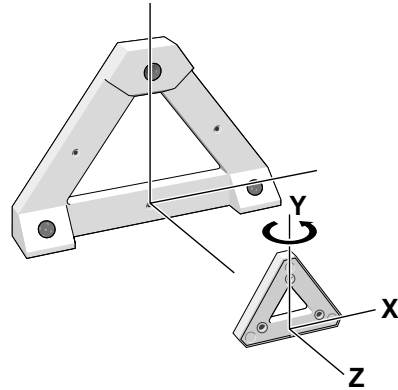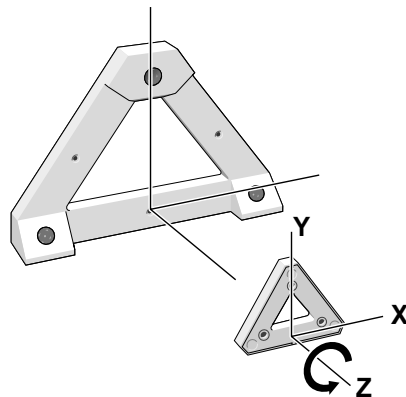

Figure 5-7. Positive Roll Rotation

Orientation data is represented in Y-X-Z Euler's angles. For example, the orientation of 0 degrees Pitch, 0 degrees Yaw, and 0 degrees Roll is reported when both of the following conditions are met:

- The receiver's reference axis Z_R is parallel to the transmitter's reference axis Z_T (see Figure 5-4).

- The receiver's microphones are facing towards the transmitter's speakers.

To position the receiver at a particular orientation (for example, Yaw = 30 degrees, Pitch = 40 degrees, and Roll = 50 degrees) from an initial starting orientation of zero degrees for Yaw, Pitch, and Roll, you must perform these steps in the order presented:

1. **Yaw the receiver 30 degrees.**

2. **Pitch the receiver 40 degrees.**

3. **Roll the receiver 50 degrees.**

Converting Euler's Angles to Quaternions

The Quaternions coordinate system is another way of representing orientation. This system uses four coordinates to specify orientation in a smoother, more natural way. (For more information about using Quaternions to specify rotation in space, see the Siggraph 1985 paper: "Animating Rotation with Quaternion Curves" by Ken Shoemake, San Francisco, July 22-26.)

If you prefer to use Quaternions to define orientation instead of Euler's angles, the following formulas will help you convert from Euler's angles.

$w = \cos(R/2) \cdot \cos(P/2) \cdot \cos(Y/2) + \sin(R/2) \cdot \sin(P/2) \cdot \sin(Y/2)$

$x = \cos(R/2) \cdot \sin(P/2) \cdot \cos(Y/2) + \sin(R/2) \cdot \cos(P/2) \cdot \sin(Y/2)$

$y = \cos(R/2) \cdot \cos(P/2) \cdot \sin(Y/2) + \sin(R/2) \cdot \sin(P/2) \cdot \cos(Y/2)$

$z = \sin(R/2) \cdot \cos(P/2) \cdot \cos(Y/2) + \cos(R/2) \cdot \sin(P/2) \cdot \sin(Y/2)$

Converting Degrees to Radians

Radians are a unit of angular measure for rotation. If you prefer to use radians instead of degrees, the following formulas will help you convert from degrees. To convert degrees to radians, use the following formulas:

$P = P \cdot \pi/180$
$Y = Y \cdot \pi/180$
$R = R \cdot \pi/180$

Active Area

From each transmitter speaker, ultrasonic sound disperses in a spherical, 100-degree cone. These three cones of sound overlap in a dispersion pattern shown in Figure 5-8. Where these cones overlap is the active area of communication. The active area extends 5 feet from each transmitter speaker. The receiver should be within this area.
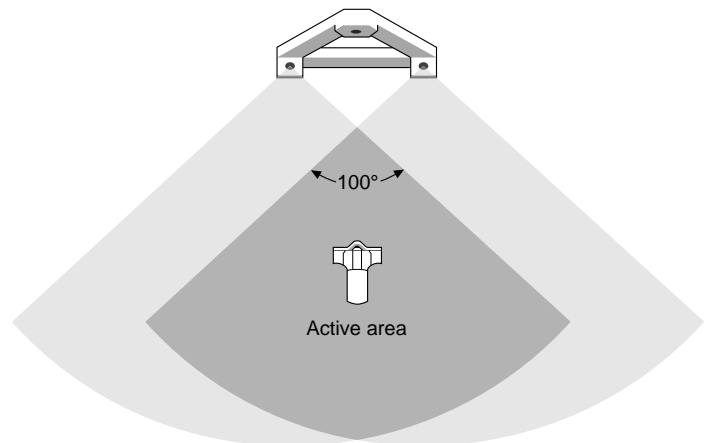
Figure 5-8. The Active Area

Resolution

In 3D mode within the active area, the resolution along the X, Y, and Z axes is 1/250 of an inch. The resolution in the Pitch, Yaw, and Roll rotations is 1/10 of a degree.

Fringe Area and Out-of-Range Area

The fringe area is a 1-foot band along the edge, within the active area (see the block diagram in Figure 5-9).
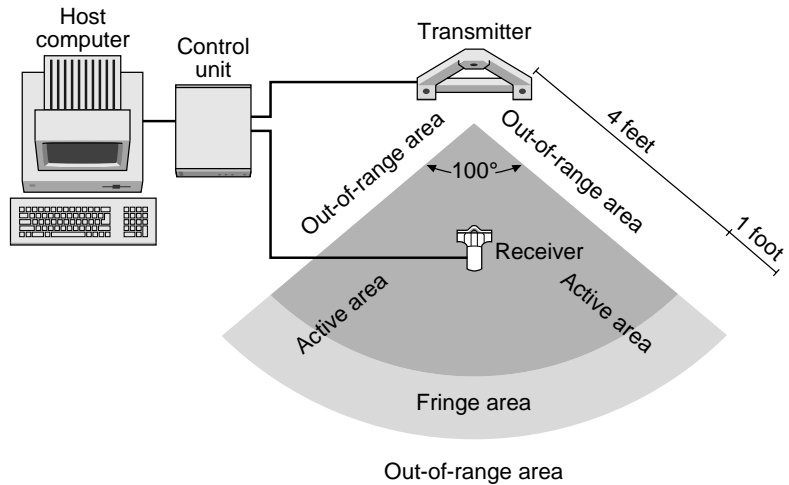
Figure 5-9. The Fringe and Out-of-Range Areas

When you move the receiver into this fringe area, the control unit sets a FRINGE bit in the first byte of its data report to the host computer. (The control unit's data report tells the host computer the position and orientation of the receiver, see 3D Mode, Mouse Data Report Format" in Chapter 6.) The application can use the FRINGE bit to warn the user that the receiver is approaching the limits of the active area.

When the receiver is out of range, the control unit sets an OUT bit in the first byte of its data report to the host computer. This data report contains the last valid report when the receiver was in range. This last valid report allows the application to use the returned data report.

If the receiver is out of range when the control unit returns the first data report, the control unit sets the OUT bit and the positional and orientation data contains all zeros. This allows the application to notify the user to move the receiver into range.

Also, if the receiver's tracking speed exceeds 30 inches per second, the control unit sets the OUT bit.

Note   The FRINGE bit and the OUT bit are mutually exclusive; therefore, the control unit never sets both bits simultaneously.

The FRINGE Bit

The FRINGE bit is located at Bit 6 in the first byte of the 3D mode mouse data report (see Table 6-2 in Chapter 6).

The OUT Bit

The OUT bit is located at Bit 5 in the first byte of the 3D mode mouse data report (see Table 6-2 in Chapter 6). This bit signifies three out-of-range conditions:

- when you move the receiver out of the out-of-range area
- when the receiver is not in a direct line of communication with the transmitter
- when you move the receiver faster than the maximum tracking speed

OUT Bit Set-First Report. The OUT bit in the first byte of the data report is as follows (if the receiver is not in range, and has never been in range since you powered on or initialized the control unit, when the report is requested):

> 1x1xxxxx*   byte 1
> 00000000   byte 2 through byte 16

*The letter "x" means "don't care," could be 0 or 1.

This "all-zero" data report is repeated until you move the receiver in range, because the control unit always returns the last valid position and orientation in 3D mode. In this case, there has been no previously valid information.

OUT Bit Example

If your application converts absolute information into relative information, prompt the user to move the receiver into range before completing the control unit's initialization. This approach avoids a large relative change in position/orientation from the all-zero data report to the first valid data report. The following is a C pseudo-code example:

```
// go get the data report
get_report (report);

// first report valid?
if (report [0] & logitech_OUTBIT) {

   // first report invalid, request user to move the
   receiver printf ("Please move the Logitech receiver in
   range.\n");

   // stick around until I get a valid data report
   do {

      // go get another report
      get_report (report);

   } while (report [0] & logitech_OUTBIT);

   //cheers to the user
   printf ("Logitech receiver detected.\n");

}
// squirrel away the report for later processing
save_report (report);
```

OUT Bit Set-Out of Range or Obscured. After the first data report, the unit always has a last-valid data report. Therefore when the receiver moves out of range or the ultrasonic path is obstructed, the position and orientation data reflects the last valid data report.

For applications that convert absolute information to relative changes, the data report can usually be used as is. In effect, the sensor is not tracked until it is brought back into range.

For applications using absolute information directly, old valid information is typically not acceptable to use. So, the OUT bit notifies the user, via the application, that the point is invalid.

Note   All the mouse buttons will operate regardless of the status of the OUT bit. In other words, the mouse does not need to be in range for button toggling.

Tracking Speed

In 3D mode, the receiver accurately tracks up to 30 inches per second (ips). If the speed exceeds 30 ips, the control unit sets the OUT bit.

Reporting Modes

In 3D mode, the control unit reports to the host computer in three modes: demand, incremental, and stream. Demand reporting mode is default.

Demand Reporting Mode. In this mode, the control unit sends a single report only when requested by the host computer.

Incremental Reporting Mode. In this mode, the control unit reports automatically each time the receiver changes position or orientation.

Stream Reporting Mode. In this mode, the control unit reports at the maximum rate regardless of the receiver movement.

2D Mode

In 2D mode, you can move the 3D Mouse on a flat surface (the desktop or table). It behaves like a conventional 2- or 3-button mouse. The control unit reports button activity and two-dimensional movement to the host computer.

Using the Suspend buttons or picking the mouse up from the desk suppresses mouse reports. These actions enable you to reposition the mouse without moving the screen object.

Active Area

In 2D mode, the active area is the same as in 3D mode; however, it is limited to a ½-inch space above the base of the transmitter on the Y axis. For example, if you raise the 3D Mouse over a ½ inch above the base of the transmitter, the receiver is out of range.

Resolution

In 2D mode, the resolution is 400 dpi within the active area. The resolution can be reduced at the driver level to support any resolution up to 400 dpi.

Tracking Speed

In 2D Mode, the 3D Mouse tracking speed is also 30 inches per second.

Reporting Mode

In 2D Mode, the control unit reports in Incremental report mode *only*. The maximum reporting rate is 44 reports per second.

6

Application Programming Interface

This chapter describes how to initialize the control unit. It also describes the 2D and 3D mode command set.

Examples of how to use the 3D Mode command set are included in the 3D Mouse driver source code provided on the program disk.

Control Unit Initialization

This section describes how to initialize or reset the control unit and the subsequent effects on the control unit.

You can initialize the control unit in any one of three ways:

a.   Turn on the control unit.

b.   Send the *R (Software Reset) command to the control unit from the host computer (see the Software Reset command in the "3D Mode Commands" section later in this chapter).

c.   Perform an RTS line toggle on the RS-232 interface. The RTS toggle occurs when the RTS line is negative for at least 100 ms, and then becomes positive. (See restrictions below.)

Procedures a. and b. cause the control unit to enter 3D Mode initialization. The three green LEDs on the control unit's front panel toggle on and off. 3D Mode initialization sets the serial port to 19,200 bps: 8 data bits, no parity, and 1 stop bit. No characters are sent back to the host computer.

After 3D Mode initialization, the driver should wait at least 1 second and perform an *<enq> (Diagnostics) command to ensure that the control unit is functioning properly. For more information about the Diagnostics command, see the "3D Mode Commands" section later in this chapter.

Procedure c. causes the control unit to enter 2D Mode initialization. 2D Mode initialization sets the serial port to 1200 bps: 7 data bits, no parity, and 1 stop bit. The end of the initialization sends the following two-character status message back to the host computer (see Table 6-1).

Figure 6-1. 2D Mode End Status Message

ASCII	HEX	Function
M,3	4D,33	3 button device declaration

This status message tells the host computer that the initialization routine has been completed and the control unit is in 2D Mode.

Upon power on, reset, or RTS toggle, the 3D Mouse sends back one or two characters specifying the type of device-M3. The driver must determine what type of device is connected. This is performed by sending the *? (Send Standard Configuration) command. The device should respond within 100 ms.

3D Mode

The sections that follow describe the 3D Mouse data report format, the data format restrictions, and the 3D Mode command set.

Mouse Data Report Format

The control unit reports 3D Mode activity to the host computer, such as position, orientation, and button activity via the mouse data report. The size of the mouse data report is 16 bytes (see Table 6-2).

Figure 6-2. Mouse Data Report Sixteen-Byte Format

Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	1	FRI	OUT	P	S	L	M	R
Byte 2	0	X20	X19	X18	X17	X16	X15	X14
Byte 3	0	X13	X12	X11	X10	X9	X8	X7
Byte 4	0	X6	X5	X4	X3	X2	X1	X0
Byte 5	0	Y20	Y19	Y18	Y17	Y16	Y15	Y14
Byte 6	0	Y13	Y12	Y11	Y10	Y9	Y8	Y7
Byte 7	0	Y6	Y5	Y4	Y3	Y2	Y1	Y0
Byte 8	0	Z20	Z19	Z18	Z17	Z16	Z15	Z14
Byte 9	0	Z13	Z12	Z11	Z10	Z9	Z8	Z7
Byte 10	0	Z6	Z5	Z4	Z3	Z2	Z1	Z0
Byte 11	0	PI13	PI12	PI11	PI10	PI9	PI8	PI7
Byte 12	0	PI6	PI5	PI4	PI3	PI2	PI1	PI0
Byte 13	0	YA13	YA12	YA11	YA10	YA9	YA8	YA7
Byte 14	0	YA6	YA5	YA4	YA3	YA2	YA1	YA0
Byte 15	0	RO13	RO12	RO11	RO10	RO9	RO8	RO7
Byte 16	0	RO6	RO5	RO4	RO3	RO2	RO1	RO0

Where in Table 6-2,

FRI	= Mouse has entered the fringe space.	
OUT	= This report is invalid-the mouse is out of range.	
P	= Mouse stand button	1 = pressed
0S	= Suspend button	1 = pressed (left or right Suspend button pressed)
L	= Left button	1 = pressed
M	= Middle button	1 = pressed
R	= Right button	1 = pressed
X20-X0	= X distance	see following restrictions
Y20-Y0	= Y distance	see following restrictions
Z20-Z0	= Z distance	see following restrictions
PI13-PI0	= PITCH rotation	see following restrictions
YA13-YA0	= YAW rotation	see following restrictions
RO13-RO0	= ROLL rotation	see following restrictions

Data Format Restrictions

This section describes the restrictions that are associated with the X, Y, Z, Pitch, Yaw, and Roll values in Table 6-2.

• X, Y, and Z fields correspond to signed numbers with absolute maximum values of -1048576 and +1048575 (or 221). Each bit in the X, Y, and Z fields represent a dot with a resolution of 1/1000 inch. Therefore, the maximum spatial range is approximately ±1048 inches or ±87 feet from the origin of each axis.

• Pitch, Yaw, and Roll fields correspond to unsigned binary numbers with absolute maximum values of 16383. Each bit in these fields represent one part, with a resolution of 40 parts per degree. The maximum rotational range is 360 degrees, and the maximum number of parts required to cover the entire rotational range is 14400 (0-14399).

   The 3D Mouse rotation is measured in 10 parts per degree. Therefore, the lower two bits of the Pitch, Yaw, and Roll fields are always 0.

• In 3D mode, mouse data reports are 16 bytes in length, with 10 bits transmitted per byte (1 start bit, 8 data bits, and 1 stop bit). The software generates reports at a maximum rate of 50 reports per second.

3D Mode Commands

This section describes the standard 3D Mode command set. The standard 3D mode command sent to the 3D Mouse control unit from the host computer consists of two or more characters with the first always being an asterisk "*" (2A hex). You must issue all 3D mode commands except the Software Reset (*R) command and the Demand Reporting (*D) command) while the system is in the Demand reporting mode. You can issue the exceptions in any 3D reporting mode.

In 3D mode, the control unit ignores all characters not part of the 3D mode command set (see Table 6-3) and all characters not transmitted at 19,200 bps.

Figure 6-3. 3D Mode Commands

ASCII	HEX	Function
*<	2A, 3C	Invoke 2D Mode
*R	2A, 52	Software Reset
*D	2A, 44	Demand Reporting
*d	2A, 64	Demand a Single Report
*I	2A, 49	Incremental Reporting
*S	2A, 53	Stream Reporting
*<enq>	2A, 05	Diagnostics
*A	2A, 41	Enable Transmitter Output
*O	2A, 4F	Disable Transmitter Output
*m	2A, 6D	Current Operating Information
*$…	2A, 24	Set Slave Transmitter
*$…	2A, 24	Set Filter Count
*$…	2A, 24	Set Custom Receiver Dimensions

Invoke 2D Mode (*<)

The *< switches the control unit from 3D to 2D Mode. The serial port is set to 1200 bps: 7 data bits, no parity, and 1 stop bit.

Software Reset (*R)

The *R command resets the control unit. You can issue this command in any 3D reporting mode.
Wait at least 1 second after the software reset command before sending any other commands. This allows the initialization process to complete.

Demand Reporting (*D)

The *D command switches the control unit to the Demand reporting mode. In this mode, the control unit stops generating mouse data reports automatically and only generates a mouse data report upon request via a *d (Demand a Single Report) command. You can issue the *D command in any 3D reporting mode. If you issue this command while the control unit is transmitting a report, the report will continue to the end and will not be truncated.

Demand a Single Report (*d)

The *d command causes the control unit to transmit the last valid 3D [mouse data report. If the receiver or transmitter are not operating, or if the receiver is not in a valid tracking space, the points returned from successive single report commands will not change. Position and orientation data for the receiver is updated every 20 ms within the control unit. Therefore, the mouse data report received in Demand reporting mode can be delayed up to 20 ms from when the control unit has updated the position and orientation data for the receiver. You can only issue this command in Demand Reporting mode.

Incremental Reporting (*I)

The *I command switches the control unit to the Incremental reporting mode. In this reporting mode, the control unit sends mouse data reports continuously as long as the receiver is moving. The host computer may have to keep up with an information flow of up to 50 reports per second.

Stream Reporting (*S)

The *S command causes the control unit to enter the Stream reporting mode. In Stream reporting mode, the control unit sends mouse data reports continuously. The host computer may have to keep up with an information flow of 50 reports per second.

Diagnostics (*<enq>)

The *<enq> command causes the control unit to return a two-byte response containing diagnostic information (see Table 6-4).

Figure 6-4. Diagnostic Response

Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	1	0	T5	T4	T3	T2	T1	T0
Byte 2	0	0	TB	TA	T9	T8	T7	T6

Where in Table 6-4,

    TO   = Control Unit test
    T1   = Processor test
    T2   = EPROM checksum test
    T3   = RAM test
    T4   = Transmitter test
    T5   = Receiver test
    T6   = Serial Port test
    T7   = EEPROM test
    T8   = Reserved
    T9   = Reserved
    TA   = Reserved
    TB   = Reserved

In the above test results, a "0" indicates that the test failed. A "1" indicates that the test passed. Therefore, a BF 3F (hex) represents an "All Pass" result. Any other response indicates that at least one test failed.

Enable Transmitter Output (*A)

The *A command enables the speaker output from the transmitter (see Table 6-5). Speaker output enabled is the default.

Disable Transmitter Output (*0)

The *O command disables the speaker output from the transmitter (see Table 6-5).

Figure 6-5. Enable/Disable Transmitter Output Commands

ASCII	HEX	Function
*A	2A, 41	Enable Transmitter Output
*O	2A, 4F	Disable Transmitter Output

Current Operating Information (*m)

The *m command causes the control unit to return a 30-byte current operating information report (see Table 6-6).

Figure 6-6. Current Operating Information Command Format

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	1	0	V5	V4	V3	V2	V1	V0
Byte 2	0	D6	D5	D4	D3	D2	D1	D0
Byte 3	0	RM6	RM5	RM4	RM3	RM2	RM1	RM0
Byte 4	0	RD6	RD5	RD4	RD3	RD2	RD1	RD0
Byte 5	0	RS6	RS5	RS4	RS3	RS2	RS1	RS0
Byte 6	0	T6	T5	T4	T3	T2	T1	T0

Figure 6-6. Current Operating Information Command Format

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 7	0	MS6	MS5	MS4	MS3	MS2	MS1	MS0
Byte 8	0	A6	A5	A4	A3	A2	A1	A0
Byte 9	0	RCV6	RCV5	RCV4	RCV3	RCV2	RCV1	RCV0
Byte 10	0	XMT6	XMT5	XMT4	XMT3	XMT2	XMT1	XMT0
Byte 11	LRR7	LRR6	LRR5	LRR4	LRR3	LRR2	LRR1	LRR0
Byte 12	LRR15	LRR14	LRR13	LRR12	LRR11	LRR10	LRR9	LRR8
Byte 13	LTR7	LTR6	LTR5	LTR4	LTR3	LTR2	LTR1	LTR0
Byte 14	LTR15	LTR14	LTR13	LTR12	LTR11	LTR10	LTR9	LTR8
Byte 15	RES	RES	RES	RES	RES	RES	RES	BD0
Byte 16	LRX7	LRX6	LRX5	LRX4	LRX3	LRX2	LRX1	LRX0
Byte 17	LRX15	LRX14	LRX13	LRX12	LRX11	LRX10	LRX9	LRX8
Byte 18	LTX7	LTX6	LTX5	LTX4	LTX3	LTX2	LTX1	LTX0
Byte 19	LTX15	LTX14	LTX13	LTX12	LTX11	LTX10	LTX9	LTX8
Byte 20	LCX7	LCX6	LCX5	LCX4	LCX3	LCX2	LCX1	LCX0
Byte 21	LCX15	LCX14	LCX13	LCX12	LCX11	LCX10	LCX9	LCX8
Byte 22-30	RES	RES	RES	RES	RES	RES	RES	RES

Where in Table 6-6,

V5…V0 = Firmware Version Index (same as in 2D command, *?)
1 = Firmware Version 1.0
2 = Firmware Version 2.0
3 = Reserved
4 = Firmware Version 1.1
5 = Reserved

Where in Table 6-6 (continued),

D6…D0 = Dimension
    D0 = 2D mode
    D1 = 3D mode

RM6…RM0 = Reporting Mode
    RM0 = Incremental Reporting
    RM1 = Demand Reporting
    RM2 = Stream Reporting

RD6…RD0 = Reporting Data Type
    RD0 = Euler Data Type (Default)

RS6…RS0 = Reporting Data Record Size (in number of bytes)

T6…T0 = Tracking Mode
    T0 = Mouse Tracking (Default)

MS6…MS0 = Master/Slave Status
    MS0 = Slave
    MS1 = Master

A6…A0 = Audio Level
    Value = 0 (Audio Off)
    Value = 1 (Audio On)

RCV6…RCV0 = Receiver Type Connected
    Value = 15 (No Receiver Connected)
    Value = 14 (Mouse Receiver)
    Value = 13 (Head Tracker Receiver)
    Value = 12 (Mouse Receiver with Pedestal)
    Value = 11 (Crystal Eyes VR Receiver)
    Value = 10 through 2 (Reserved)
    Value = 1 (Custom Receiver)
    Value = 0 (Reserved)

Where in Table 6-6 (continued),

XMT6…XMT0 = Transmitter Type Connected
Value = 15 (No Transmitter Connected)
Value = 14 (Mouse Transmitter Frame)
Value = 13 (Head Tracker Transmitter Frame)
Value = 12 through 0 (Reserved)

LRR15…LRR0 = Distance from receiver's lower left microphone to
lower right microphone (.001 inch units)

LTR15…LTR0 = Distance from receiver's lower microphone to top
microphone (.001 inch units)

BD0 = Button Disabled Status
Value = 1 (Buttons Disabled on Receiver)
Value = 0 (Buttons Enabled on Receiver)

LRX15…LRX0 = Distance from transmitter's lower speaker to lower
right speaker (.001 inch units)

LTX15…LTX0 = Distance from transmitter's lower left speaker to
top speaker (.001 inch units)

LCX15…LCX0 = Distance from transmitter's lower left speaker to
calibration microphone (.001 inch units)

RES = Reserved for future extensions [0]

Set Slave Transmitter Type

This command sets the Slave control unit's transmitter type. The
command structure is in a hex, 5-byte format as follows:

Byte 1   2A
Byte 2   24
Byte 3   02
Byte 4   01
Byte 5   Slave's transmitter type

The transmitter-type byte is generally derived from sending the *m
(Current Operating Information) command to the Master control unit,
and getting the Master control unit's transmitter type. The Master control
unit's transmitter type is also the Slave control unit's transmitter type.

Set Filter Count

Inside the firmware is a filtering system that reduces data jitter (a slight fluctuation in the position and orientation data when the receiver is stationary). Increasing the filter count reduces the amount of jitter, but increases the system latency (the length of time that elapses between when the receiver moves and when the control unit reports the receiver's movement). Each additional filter count above 1 increases the latency an additional 20 ms. Permissible filter count values are 1 to 10. The default is 1. The command structure is in a hex, 5-byte format as follows:

Byte 1	2A
Byte 2	24
Byte 3	02
Byte 4	07
Byte 5	Filter count

Set Custom Receiver Dimensions

If you create your own custom receiver, send the Set Custom Receiver Dimensions command to the control unit, and notify the control unit of the dimensions of the custom receiver. The command structure is in a hex, 10-byte format as follows:

Byte 1	2A
Byte 2	24
Byte 3	07
Byte 4	08
Byte 5	01
Bytes 6 & 7	The distance from the Lower Left Microphone to the Lower Right Microphone is calculated in .001 inch units (2 Bytes Low Byte, High Byte order).
Bytes 8 & 9	The distance from the Lower Left Microphone to the Top Microphone is .001 inch units (2 Bytes Low Byte, High Byte order).
Byte 10	The Button Disabled status is stored in one byte and is as follows: 1 = Buttons Disabled on Receiver 0 = Buttons Enabled on Receiver

2D Mode

The sections that follow describe the 2D Mode reporting data formats and the 2D Mouse emulation command set.

Reporting Data Formats

The control unit reports mouse activity to the host computer in one of two formats: the Logitech M+ Format (3-button mouse support) and the MS-Compatible Format (Microsoft 2-button mouse support). The default format is Logitech M+.

Logitech M+ Format (Full 3-Button Mouse Support)

To switch the control unit to Logitech M+ Format, issue the command shown in Table 6-7.

Figure 6-7. Logitech M+ Format Command

ASCII	HEX	Function
*X	2A, 58	Select M+ format

The M+ format differs from the MS-Compatible format only in that a fourth data byte is added to the report when the following occurs:

- The user presses the middle button since the last report.
- A report is sent while the user presses the middle button.
- The user releases the middle button.

The four-byte M+ format is shown in Table 6-8.

Figure 6-8. M+ Mouse Report Format

Name	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	1	L	R	Y7	Y6	X7	X6
Byte 2	0	X5	X4	X3	X2	X1	X0
Byte 3	0	Y5	Y4	Y3	Y2	Y1	Y0
Byte 4	0	M	DT4	DT3	DT2	DT1	DT0

- The fourth byte is transmitted only when one of the middle button conditions is met.

Where in Table 6-8,

L = Left Button, "1" = pressed
R = Right Button, "1" = pressed
M = Middle Button, "1" = pressed

$X7...X0$ = X movement since the last report is expressed as an 8 bit two's complement value (-128 to +127); positive East.

$Y7...Y0$ = Y movement since the last report is expressed as an 8-bit two's complement value (-128 to +127); positive South.

$DT4...DT0$ = Device type; 5 bits interpreted as follows:
0 = Unknown
1 = Mouse
2 = Trackman(tm)
3 = Trackman Portable(tm)
4 = 3D Mouse
5...31 = Reserved for future use

In M+ format, data is transmitted in the form of seven-bit bytes. There is one stop bit and no parity bit. Each report consists of three or four bytes (depending on whether the middle button conditions are met).

The X and Y movements are relative to the X and Y positions last reported. The X movement is positive to the East and negative to the West; Y movement is positive to the South and negative to the North.

MS-Compatible Format (Microsoft 2-Button Mouse Support)

To switch the control unit to Logitech MS-Compatible Format, issue the command shown in Table 6-9.

Figure 6-9. Logitech MS-Compatible Format Command

ASCII	HEX	Function
*V	2A, 56	Select MS-Compatible format

In MS-Compatible format, each mouse report sent to the host computer consists of three bytes, each byte containing seven bits. The three bytes contain the status of each of the two buttons and the relative X and Y movements of the mouse. The format of the three bytes is shown in Table 6-10.

Figure 6-10. MS-Compatable Mouse Report Format

Name	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	1	L	R	Y7	Y6	X7	X6
Byte 2	0	X5	X4	X3	X2	X1	X0
Byte 3	0	Y5	Y4	Y3	Y2	Y1	Y0

Where in Table 6-10,

L = Left Button, "1" = pressed
R = Right Button, "1" = pressed

$X_7...X_0$ = X movement since the last report is expressed as an 8-bit two's complement value (-128 to +127); positive East.

$Y_7...Y_0$ = Y movement since the last report is expressed as an 8-bit two's complement value (-128 to +127); positive South.

2D Mode Commands

The standard 2D mode command sent to the 3D Mouse control unit from the host computer consists of two ASCII characters with the first always being an asterisk: "*" (2A hex).

In 2D mode, the control unit ignores all characters not part of the 2D mode command set (see Table 6-11) and all characters not transmitted at 1200 bps.

Figure 6-11. 2D Mode Command Set

ASCII	HEX	Function
*X	2A, 58	Select M+ Format
*V	2A, 56	Select MS-Compatible Format
*U	2A, 55	Select 5-Byte (MSC) Mode (not currently supported)
*c	2A, 63	Send Copyright and Version Number in ASCII
*?	2A, 3F	Send Standard Configuration
*!	2A, 21	Send Specific Configuration
*>	2A, 3E	Leave 2D Mode, Invoke 3D Mode

Select M+ Format (*X)

The *X command causes the control unit to switch to the Logitech M+ Format (full 3-button mouse support). Since the M+ format is the default format, issue this command to switch back from the MS-Compatible Format (Microsoft 2-button mouse support).

Select MS-Compatible Format (*V)

The *V command causes the 3D Mouse to switch to a 100% compatible Microsoft 2-button mouse format. Also, it allows the 3D Mouse to support a third button transparently. The middle mouse button is supported by simultaneously pressing or releasing both the left and right buttons.

Select 5-Byte (MSC) Format

This command is not supported in the current implementation of the 3D Mouse.

Send Copyright (*c)

The *c command causes the control unit to transmit an ASCII string of up to 127 characters to the host computer. The string contains copyright information about the control unit firmware, and is formatted as shown in Table 6-12.

Figure 6-12. Send Copyright String

Name	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte n	A6	A5	A4	A3	A2	A1	A0

Where in Table 6-7,

A6..A0 = Represents the ASCII code of the nth character transmitted

The ASCII string transmitted is

<CR><LF>JA 1.0 © 1991 Logitech<NUL>

The transmitted string is updated in each new firmware release.

Send Standard Configuration (*?)

The *? command causes the control unit to transmit a four-byte report to the host computer (see Figure 6-13). This report contains information about the firmware version, report bit rate, bit rate capabilities, device type, number of buttons, protocol, and current mouse configuration.

Figure 6-13. Send Standard Configuration Four-Byte Report Format

Name	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	1	V5	V4	V3	V2	V1	V0
Byte 2	0	RBR	BRC	EXT	DT2	DT1	DT0
Byte 3	0	B2	B1	B0	P2	P1	P0
Byte 4	0	RES	RES	RES	RES	RES	RES

Where in Table 6-13,

> $V5...V0$ = Firmware Version Index [000001] (See Table 6-6 for a description of the Firmware Version Index)
>
> RBR = Report Bit Rate before receiving a command [0]
> > 0 = The device was in 1200 bit/second mode.
> > 1 = The device was in 9600 bit/second mode. [not currently supported]
>
> BRC = Bit Rate Capabilities [0]
> > 0 = The device can transmit reports at 1200 bit/second only.
> > 1 = The device can transmit reports at 1200 and 9600 bit/second [not currently supported]
>
> EXT = Extension to Command set [1]
> > 0 = There is extension to the command set
> > 1 = The command set is extended with the "*!" command.

DT2…DT0 = Device Type [100]
      0 = Unknown
      1 = Mouse
      2 = Trackman™
      3 = Trackman Portable™
      4 = 3D Mouse
      5…7 = Reserved for future extensions

B2…B0 = Number of buttons [011]
      0 = Unknown
      1…4 = 1…4 buttons
      5…7 = Reserved for future extensions

P2…P0 = Protocol in use [010; default]
      0 = Unknown
      1 = MS-Compatible
      2 = M+
      3 = 5 Byte MSC (not currently supported)
      4…7 = Reserved for future extensions

RES = Reserved for future extensions [0]

The default string for the *? (Send Standard Configuration) command is shown in Table 6-14.

Figure 6-14. Standard Configuration Default String

Name	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	1	0	0	0	0	0	1
Byte 2	0	0	0	1	1	0	0
Byte 3	0	0	1	1	0	1	0
Byte 4	0	0	0	0	0	0	0

In hexadecimal, this string translates to 41, 0C, 1A, 00.

Send Specific Configuration (*!)

The *! command relays device-specific information to the host computer. This command causes the control unit to send a seven-byte message containing information about the 3D Mouse's configuration (see Table 6-15).

> Note: Currently, the majority of space in the Send Specific Configuration report is reserved for future extensions.

Figure 6-15. Specific Configuration Information

Name	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	1	T5	T4	T3	T2	T1	T0
Byte 2	0	RES	RES	RES	RES	RES	RES
Byte 3	0	RES	RES	RES	RES	RES	RES
Byte 4	0	RES	RES	RES	RES	RES	RES
Byte 5	0	RES	RES	RES	RES	RES	RES
Byte 6	0	RES	RES	RES	RES	RES	RES
Byte 7	0	RES	RES	RES	RES	RES	RES

Where in Table 6-15,

$T5…T0$ = Type of device extension [000010]
0 = Unknown
1 = Wireless Device
2 = 3D Mouse
3 = Reserved

RES = Reserved for future extensions [0]

The current-release report that is transmitted to the host computer is shown in Table 6-16.

Figure 6-16. Current Send Specific Configuration Report

Name	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte 1	1	0	0	0	0	1	0
Byte 2	0	0	0	0	0	0	0
Byte 3	0	0	0	0	0	0	0
Byte 4	0	0	0	0	0	0	0
Byte 5	0	0	0	0	0	0	0
Byte 6	0	0	0	0	0	0	0
Byte 7	0	0	0	0	0	0	0

In hexadecimal, this string translates to 42, 00, 00, 00, 00, 00, 00.

Enter 3D Mouse Emulation (*>)
The * command switches the 3D Mouse from 2D Mode to Mode. It also switches the serial port to 19,200 bps: 8 data bits, no parity, and 1 stop bit.

7

Questions & Answers

This chapter describes how you can solve problems that may occur while you're using the 3D Mouse and Head Tracker systems.

What should I do if an error appears when I run the TEST3D program?

If an error message appears on the screen when you run the TEST3D program, it means that a component failure has possibly occurred. Try the following troubleshooting procedures:

- See "Diagnostics <*enq>" in Chapter 6.

- Reboot your system through drive A.

- Ensure that all component cables are connected properly.

- Check communication (COM) ports and interrupt settings.

- Listen closely to the transmitter and ensure that there is a humming sound.

- Ensure that the red LED indicator on the control unit's front panel is on.

- Run the TEST3D program (see Chapter 2).

- Setup the 3D Mouse or Head Tracker system on another computer.

What should I do if the Red LED on the control unit won't light?

If the red LED indicator on the front panel fails to light, perform each of the following checks until the problem is resolved:

- Check that the power supply is plugged into an AC outlet and connected to the control unit.

- Check that the control unit is turned on.

- Check that AC power is available at the AC outlet.

Can I connect a Head Tracker and 3D Mouse receiver to one computer and track them both?

Yes. You can use two receivers at the same time with two control units. To connect multiple control units, see "Connecting Multiple Control Units" in Chapter 4.

I've connected multiple control units properly using the Master/Slave cable. Why won't the transmitter work?

Even though you've connected the control units properly, you may have connected the transmitter to the wrong control unit. Ensure that you've connected the transmitter to the "Master" control unit. If you've connected the transmitter to a "Slave" control unit, it won't work.

What is the 3D Mouse and Head Tracker operating range?

The active area is a 100-degree, spherical cone that extends from the transmitter for 5 feet, see "Active Area" and "Fringe Area and Out-of-Range Area" in Chapter 5.

Can I setup two transmitters in the same room?

Yes, as long as the transmitters are not facing each other. To avoid interference, we recommend that you position each transmitter facing in the same direction and allow a 10-foot separation.

A

3D Mouse & Head Tracker Specifications

This appendix defines the 3D Mouse and Head Tracker system specifications.

3D Mouse Components

3D Mouse Transmitter
3D Mouse Receiver
Control Unit
Power Supply
Computer Cable

Head Tracker Components

Head Tracker Transmitter
Head Tracker Receiver
Control Unit
Power Supply
Computer Cable

TEST3D Program Minimum System Requirements

IBM PC or compatible computer with the following:
386 or above
Coprocessor
VGA graphics adapter
3 ½-inch floppy drive
2 MB (megabytes) of RAM
DOS 5.0

Operating Modes

Dimensional Modes
2D Mode
3D Mode

Reporting Modes
Demand Reporting (3D Mode Default)
Incremental Reporting (2D Mode Default)
Stream Reporting

Reporting Formats
2D Mode (M+ and MS)
3D Mouse (Mouse Data Report)

2D Mode Pointing Device Compatibility
3-button Logitech
2-button Microsoft

Tracking Speed
Up to 30 inches per second (ips)

Tracking Area
5-foot-long, 100-degree cone

Resolution
Position. 2D Mode (400 dpi); 3D Mode (1/250 inch)
Orientation. 2D Mode (not applicable); 3D Mode (1/10 degree)

Ultrasonic Sound Frequency
23 kilohertz (kHz)

Latency
30 milliseconds (ms)

Reporting Rate
Demand Reporting: up to 50 reports per second
Incremental Reporting: up to 50 reports per second
Stream Reporting: 50 reports per second only

Accuracy
The accuracy is 2% of the distance between the transmitter and the
receiver.

Operating Temperature
5 to 35 degrees Centigrade

Operating Relative Humidity
10 to 90% non-condensing

Reliability
Electrical MTBF: 20,000 hours

Control Unit Connectors
Power supply: 2-pin male
Master/Slave: 15-pin high-density, D-sub
Transmitter: 9-pin, mini-DIN, female
Receiver: 8-pin, mini-DIN, female
Audio Out: 5-pin, mini-DIN, female
Serial port: 7-pin, mini-DIN, female

Audio Output
Amplitude: 1 Vp-p, 600 Ohm load
Band Width: 15 Hz to 5 kHz

Audio Input
The top microphone on the 3D Mouse and Head Tracker receivers
supports audio input.

Pin Assignments
Audio Out
To support the Audio-Out feature, the control unit is equipped with a 5-
pin, mini-DIN socket (see Figure A-1) with pin assignments shown in
Table A-1.
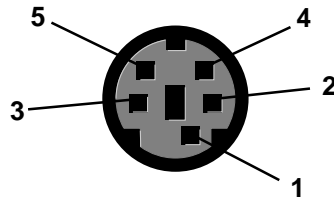
Figure A-1. Audio-Out Connector

Table A-1. Audio Out Pin Assignments

Pin No.	Signal Name	Signal Type
1	GND	
2	LINE_OUT	Analog Output
3	Reserved	
4	EN_VOICE	TTL Output
5	Shield GND	

Serial Port
Table A-2 shows the control unit's Serial Port connector pin assignments.

Table A-2. Serial Port Connector Pin Assignments

Pin No.	Signal Name	Signal Type
1	CTS	Input
2	RXD	Input
3	TXD	Output
4	DTR	Output
5	GND	
6	DSR	Input
7	RTS	Output

Table A-3 shows the pin assignments for the computer cable's 9-pin, D-Sub, serial port connector.

Table A-3. 9-Pin, D-Sub Serial Port Pin Assignments

Pin No.	Signal Name	Signal Type
1	Not Connected	
2	RXD	Input
3	TXD	Output
4	DTR	Output
5	GND	
6	DSR	Input
7	RTS	Output
8	CTS	Input
9	Not Connected	

Note   All serial port inputs and outputs are EIA RS-232C compatible. Also, all signal names and signal types are from the point of view of the host.

Table A-4 shows the pin assignments for the 9- to 25-pin adapter.

Table A-4. 9- to 25 Pin, Adapter Pin Assignments

9-Pin	25-Pin	Data Signals
Shell	1	Protective GND
3	2	Receive Data (To Mouse)
2	3	Transmit Data (From Mouse)
7	4	Request to Send
8	5	Clear to Send
6	6	Data Set Ready
5	7	Signal GND
4	20	Data Terminal Supply

AC Power
Supplied Power Supply
115 volts AC; 60 Hz

Optional Power Supply
220 volts AC; 50 Hz

Component Cable Lengths
Transmitter: 6 feet
Receiver: 9.5 feet
Power Supply: 6 feet
Computer Cable: 6 feet
Master/Slave: 2 feet

Physical Dimensions
Control Unit
Depth: 9 1/2 inches (240 mm)
Height: 1 5/8 inches (41 mm)
Width: 7 1/4 inches (185 mm)

3D Mouse Transmitter
Depth: 3 5/8 inches (93 mm)
Height: 7 3/4 inches (196 mm)
Width: 11 inches (280 mm)

3D Mouse Receiver
Depth: 5 7/8 inches (149 mm)
Height: 2 7/8 inches (72 mm)
Width: 4 3/8 inches (110 mm)

Head Tracker Transmitter

The Head Tracker Transmitter dimensions are shown in Figure A-2.
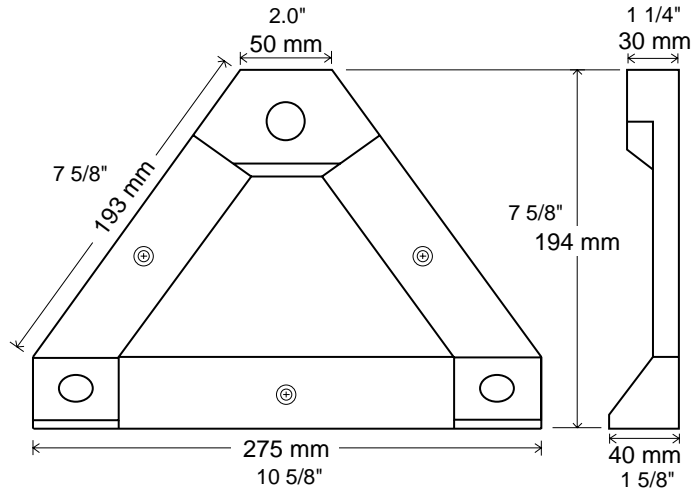
Figure A-2. Head Tracker Transmitter Dimensions

Head Tracker Receiver

The Head Tracker Receiver dimensions are shown in Figure A-3.
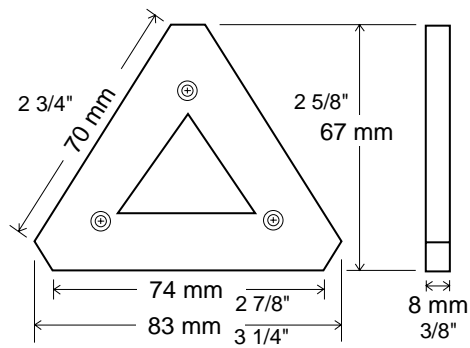
Figure A-3. Head Tracker Receiver Dimensions

B

Creating a Custom Receiver

You can create a custom 3D Mouse receiver for your work environment or application. To do so, we recommend the following:

- See the provided 3D Mouse assembly schematic (Figure B-2).

- Use a 332 ohm ID resistor value to provide a receiver value 1.

- Shape the receiver as an equilateral or isosceles triangle, with the one unequal side as the base (see points R1 to R2 in Figure B-1).
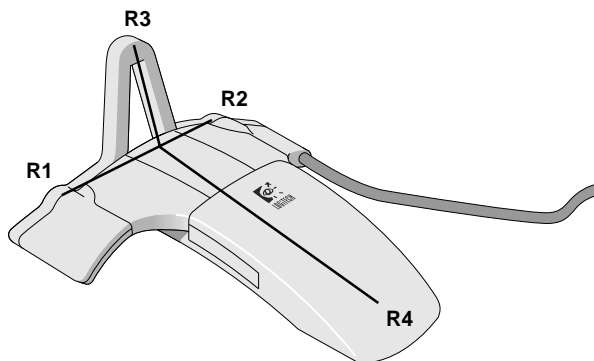
Figure B-1. 3D Mouse Points of Reference

- Position each of the microphones a minimum of 5 inches to a maximum of 10 inches apart. The wider the spacing between each microphone, the better the orientation accuracy.

  Note For information about purchasing microphones, contact Fakespace Inc. (see rear of cover).

When using a custom receiver, the control unit must know the receiver's dimensions. After you connect the receiver to the control unit and turn the power on, you must send the Set Custom Receiver Dimensions command to the control unit, see section "3D Mode Commands" in Chapter 6.
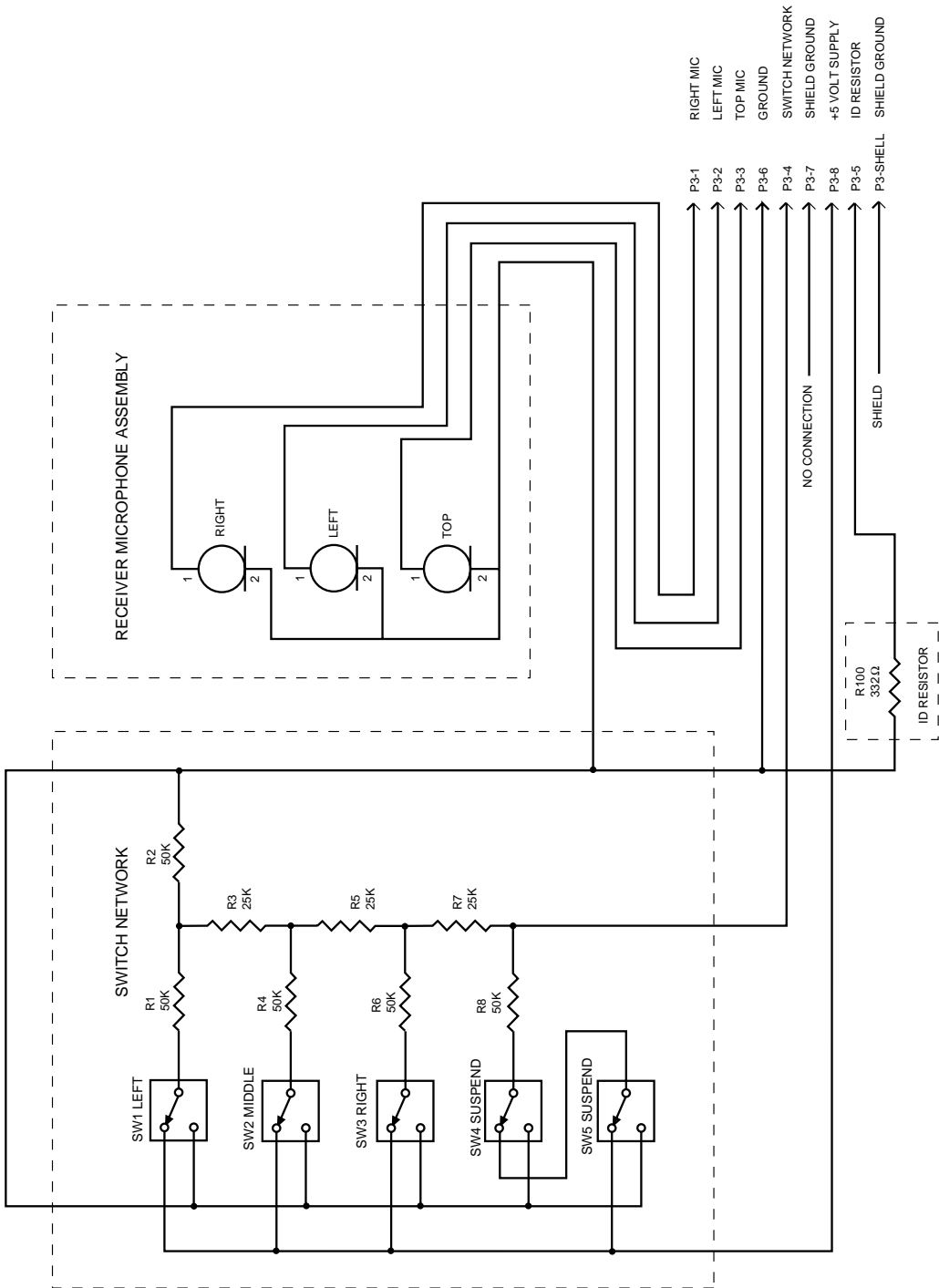
Figure B-2. 3D Mouse Assembly Schematic

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Numerics

LOGITECH™
3D MOUSE &
HEAD TRACKER

TECHNICAL REFERENCE MANUAL

Corporate Headquarters:
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Fremont, CA 94555

This product assembled in U.S.A. by:
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(650) 688-1940
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Mountain View, CA 94043
620402-00   REV C