# Mouse Systems Optical Mouse
# Technical Reference Manual

Models M2 and M3

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# FEDERAL COMMUNICATIONS COMMISSION
# RADIO FREQUENCY INTERFERENCE STATEMENT

**WARNING:** This equipment generates and uses radio frequency energy and if not installed properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause 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 the receiving antenna; Relocate the computer with respect to the receiver; Move the computer away from the receiver; or Plug the computer into a different outlet so that the computer and receiver are on different branch circuits. If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock N. 004-000-00345-4.

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# INTRODUCTION

This Technical Reference Manual describes the characteristics of Mouse Systems Corporation's M2 and M3 optical mice and provides sufficient information for the development of host hardware and software interfaces. It also describes troubleshooting information.

## Mouse Basics

The mouse transmits data to the host computer that contains information about its relative motion and the state of its switches. The surface of the pad is printed with 25 grid lines per inch; the mouse automatically further subdivides the pad's surface into a grid with 100 effective lines per inch in both the X and Y directions.

If the mouse moves one inch across the pad in the Y direction, for example, it will transmit data to the host indicating that it moved across 100 grid lines, and that it moved either in the positive or negative Y direction. Likewise, if a switch is depressed, the mouse will transmit the state of the switches.

The mouse communicates in only one direction, i.e., toward the host, and will not respond to any commands or data that originate from the host. A complete description of the data transmission protocol is included in the Mouse Protocol section on page 4.

## Connecting the Mouse to the Host Computer

1. Make sure that the computer is turned OFF.

2. Before turning on the computer, plug one end of the power supply into the jack on the mouse's RS-232C connector, then plug the power supply module into a wall outlet (120VAC). Look at the underside of the mouse: when operating properly, a bright red LED will be visible through one of the holes. The other hole will appear dark because its LED is radiating infrared light, which is invisible to the human eye.

3. Plug the RS-232C connector from the mouse into the RS-232C (COM1:) port of the computer. The cable provided with the mouse should plug directly into the back of the computer without requiring any extra adapter. Tighten the retaining screws to

insure that the connector will not be accidentally unplugged from the computer.

4. Turn the computer ON.

## Using The Mouse

Your optical mouse can work only if it is on its pad. The pad should be oriented so that the blue lines run vertically. (When viewed from above, the pad should be wider than it is tall.) Hold the mouse with its cord facing away from you. Rest the heel of your hand on the pad and grasp the sides of the mouse with your thumb and little finger. The other fingers should rest lightly on the mouse buttons.

You should be able to slide the mouse back and forth on the pad just by moving your wrist. Resting the heel of your hand on the mouse pad and moving the mouse with the wrist gives the best control and comfort. Moving the mouse with your whole arm without resting your hand on the pad may result in poor control and excessive fatigue. (Of course, many techniques are possible, and you should do what feels most comfortable to you.)

## Taking Care of the Mouse

The optical mouse requires very little maintenance. The mouse pad should be kept clean and dry and should be protected from scratches and dents. Clean the pad occasionally with a damp cloth. If the mouse pad should get wet, immediately dab up the liquid (don't wipe) and let the pad dry thoroughly before using. The mouse itself requires no maintenance, but can be cleaned as required with a damp cloth.

# THE MOUSE HARDWARE INTERFACE

The mouse connects to a host computer via an industry standard RS-232C interface. Its power is supplied by a wall mounted power adapter, whose cord plugs into the back of the mouse's connector.

## Connector and Pinouts

Mice are supplied with one of the following pinouts:

### 25-Pin D Connector

The mouse is terminated in a 25 pin female subminiature
D-connector with the following pinout:

| | |
|---|---|
| Signal: | Pin 3 |
| Ground: | Pin 7 |

### 9-Pin D Connector

A de facto 9 pin RS-232C serial interface standard has emerged. A
9-pin female D subminiature connector can be supplied with pinouts
as follows:

| | |
|---|---|
| Signal: | Pin 2 |
| Ground: | Pin 5 |

The new standard does not make provisions for host power at the
connector, so 9-pin mice require an external power module.

### RJ11C Modular Telephone Connectors

Host powered mice can be supplied with six position RJ11C
modular connectors with the following pinout:

| | |
|---|---|
| +5V: | Pin 3 |
| Signal: | Pin 4 |
| Ground: | Pin 2 |

Note: RJ11C connectors are not designed for repeated mating and
unmating.

## Voltage Levels

The signal levels transmitted by the mouse satisfy the EIA RS-232C
standard. A MARK is equal to −5V; a SPACE is equal to +5V.

# THE MOUSE SOFTWARE INTERFACE

The mouse's software interface is straightforward, and the
information that follows completely describes the protocol that the
mouse uses to communicate through an RS-232C port.

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## RS-232C Serial Port Configuration

The serial port's UART should be initialized to the following settings:

Baud Rate:  1200
Data Bits:  8
Start Bits:  1
Stop Bits:  1
Parity:  None

## Mouse Protocol

Five-byte data blocks are transmitted by the mouse when, and only when, there is a change of mouse state. The start of a data block is indicated by a sync byte whose upper five bits are 10000. The next three bits are the debounced state of the switches (0 means depressed). The next four bytes contain two updates of the mouse movement counters, $\Delta X$, $\Delta Y$, $\Delta X'$, $\Delta Y'$, where $\Delta X$ is the horizontal distance moved relative to the coordinate system of the pad since the last transmission of $\Delta X$, and $\Delta Y$ is the corresponding vertical distance. $\Delta X'$ and $\Delta Y'$ are not the same as $\Delta X$ and $\Delta Y$, but represent the distances moved since $\Delta X$ and $\Delta Y$ were transmitted. Each byte is a two's complement 8-bit binary number.

After five bytes are transmitted, additional bytes may be sent before a sync byte appears, therefore the tracking software should ignore spurious bytes until the reception of a valid sync byte.

## Direction of Motion

Positive motions are defined as being to the right in the X direction, and upward, or toward the cord, in the Y direction. Bit 7 (MSB) of the $\Delta X$ and $\Delta Y$ bytes will be 0 for positive motion and 1 for negative motion. (This coordinate system is different from many screen coordinate systems which have vertical coordinates increasing as you move down the screen.)

## Data Format

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Byte 1 | 1 | 0 | 0 | 0 | 0 | L | M | R |
| Byte 2 | X7 | X6 | X5 | X4 | X3 | X2 | X1 | X0 |
| Byte 3 | Y7 | Y6 | Y5 | Y4 | Y3 | Y2 | Y1 | Y0 |
| Byte 4 | X7 | X6 | X5 | X4 | X3 | X2 | X1 | X0 |
| Byte 5 | Y7 | Y6 | Y5 | Y4 | Y3 | Y2 | Y1 | Y0 |

X7 and Y7 = 0 for positive movement. X7 and Y7 = 1 for negative movement. (Bytes 2-5 are two's complement 8-bit binary numbers.) L,M,R are left, middle and right switches (0 means depressed.)

## Tracking Software

The basic software tracking algorithm is as follows:

1. Read a byte.

2. If the upper bits are 10000, then save the lower three bits in SWITCH_STATUS. Otherwise go back to step 1.

3. Process the lower three switch information bits if necessary.

4. Get the next byte and add its value to the variable which is accumulating horizontal movement. (Don't forget to sign extend the value to the size of the variable you are using to store accumulated mouse movement.)

5. Get the next byte and add its value to the vertical movement accumulator.

6. Get the next byte and add its value to the horizontal movement accumulator.

7. Get the next byte and add its value to the vertical movement accumulator.

8. Start again with step 1.

Each data byte should be read using interrupts. Do not read the first data byte and then loop inside the interrupt service routine until the other four bytes have been read. Instead, read a byte in the interrupt service routine, process it as appropriate, and set a counter to indicate which byte has been read. Then return from interrupt. This will minimize the time you will be running with interrupts disabled. Note that other parts of your program or operating system which run for extended periods with interrupts disabled may cause you to lose mouse bytes.

The second two delta bytes (bytes 4 and 5) are not the same as the first two. They contain information about additional mouse movement that has occurred since bytes 2 and 3 were transmitted. This information should not be ignored.

## Software Hints

The mouse's RS-232C interface transmits data only, and does not set or toggle the handshake signals (DSR, CTS, etc.). The tracking software can usually ignore these handshake signals or it can program the UART to ignore them.

When the mouse is first turned on, it transmits a continuous BREAK or Start bit for approximately 50 milliseconds (the duration of its RESET period). It may be necessary to reset the UART after the receipt of this BREAK.

The mouse transmits eight bit bytes with no parity, and all eight bits contain significant data. Operating system features that clear high order bits, swallow nulls, respond to ^S or ^Q, and/or replicate DELETE should be disabled.

Sixteen bit tracking software should propagate the sign bit (all quantities are two's complement) by using the CBW (Convert Byte to Word) instruction.

Since five bytes are transmitted at 1200 baud, the maximum velocity of the mouse must be less than 61 inches per second for real-time tracking. The mouse's position is available 48 times per second.

## Sensitivity

Many programmers choose to adjust the sensitivity of the mouse by filtering the mouse input. Sensitivity is changed by multiplying or dividing the delta motion values by a constant before moving the cursor on the screen. Multiplying causes the cursor to move further relative to mouse motion; dividing causes the cursor to move less and gives the user much finer control over its motion. Sensitivity can also be non-linear. Rapid mouse motion could move the cursor a greater distance than slow mouse motion.

A common algorithm for sensitivity doubles the cursor motion relative to the mouse motion if the mouse is moved faster than 64 transitions per second.

The appropriate sensitivity depends upon the application and the user.

## MSMOUSE

When developing special drivers, it is helpful to use the MSMOUSE

driver as a resource. A complete description of the features of the MSMOUSE driver is included in the *PC Mouse Reference Manual*, Mouse Systems part number 300548-001.

# IN CASE OF DIFFICULTY

When interfacing a mouse to a host computer, difficulties are usually caused by improper connector pinouts or an improper software interface. Some elementary troubleshooting procedures are outlined below.

## Is the Mouse Receiving Power?

Turn the mouse over and look to see if a bright red LED is visible through one of the holes. If it is not visible, the mouse is not receiving power. First, recheck the steps on page 1 of this document. Make sure that the cord from the power module is plugged into the back of the mouse connector, and that the wall outlet is working.

## Flex the Cables

Wiggle the data cable and the cable coming from the power module near their connectors to determine if there might be a loose or intermittent connection.

## Reset the Mouse

The microprocessor in the mouse can be reset easily by turning off its power. To reset the mouse:

1. Remove the mouse connector from the host.
2. Unplug the power supply from the mouse connector for a few seconds.
3. Plug the power supply back into the mouse connector.
4. Plug the mouse connector back into the host computer.

## Host Computer Software

If the LED is visible through the bottom of the mouse, and the previous steps have failed to make the mouse work correctly, the problem probably lies in the host's mouse software interface. Refer again to the Mouse Protocol section on page 4 for a description of the protocol and a suggested tracking algorithm.

## Pad Orientation

Make sure that the pad is oriented correctly. The blue lines on the pad must be vertical; the gray lines will then be horizontal. (When viewed from above, the pad should be wider than it is tall.)

## Computer Grounding

If the host computer is not connected to an earth ground via a grounding outlet there may be some cursor jitter when the mouse is lifted off its pad.

# RELATED DOCUMENTS

1. Mouse Systems Mouse Specification
   P/N 500504-001
2. Mouse Systems ESD Specification
   P/N 500505-001
3. Mouse Systems Quadrature Mouse Pinouts
   P/N 500334-001
4. Mouse Troubleshooting Procedures
   P/N 500755-001
5. UL 478 (EDP) and 114 (Office Equipment)
6. CSA 154 (EDP) and 143 (Office Equipment)
7. VDE 0806/8.81
8. BSI 5850:1981
9. SEV TP12B/1D-d
10. FCC Part 15, Subpart J, Class B
11. VDE 0871 Class B