# APPENDIX C
# MOUSE SPECIFICATION

## C.1 GENERAL DESCRIPTION

This Appendix provides information on Digital's serial mouse, shown in Figure C-1. A mouse is a hand-held pointing device used to move a cursor on a video display screen. As the mouse is moved about on a tabletop, the cursor makes corresponding movements on the screen. Once the cursor is positioned, one of the mouse buttons is pressed to make the desired selection.

Using an ergonomically designed pointing device like a mouse can make software easier to learn and use. Pointing is often faster, easier, and more accurate than with keyboard typing. Some advantages of using a mouse as a pointing device are

- Very fast positioning
- High accuracy
- Nonfatiguing
- Items on the screen are not obscured
- Stays where it was last placed
- Small, light-weight, and inexpensive.

Digital's serial mouse uses optomechanical technology to detect movement, with a resolution of 200 counts/in. A dedicated microprocessor inside the mouse converts quadrature X-Y pulses to relative X-Y coordinates, which are then transmitted as serial data to the host computer. A rubber-coated ball on the underside of the mouse provides excellent tracking on most desktop surfaces.

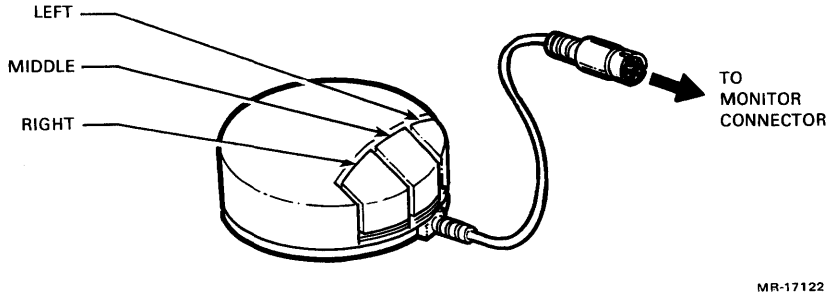


Figure C-1 Three-Button Mouse

## C.2 INSTALLATION

### C.2.1 System Hook-up

The mouse is shipped fully assembled and ready to operate. To connect the mouse, plug its cable into the mouse/tablet input jack of the computer or terminal on which it will be used. The mouse/tablet input jack is normally located on the rear panel of a video monitor.

### C.2.2 Installing/Removing the Mouse Ball

The rubber-coated ball on the underside of the mouse can be removed for cleaning or replacement without special tools. To clean the ball, use water and, if necessary, a mild soap. Do not use organic solvents such as toluene; they damage the ball's rubber coating.

Clean the ball when the cursor fails to track the mouse smoothly. In an average office environment, cleaning the ball every six months should be sufficient.

To replace the mouse ball, turn the mouse upside down to locate the ball housing cover. Remove the cover by turning it counterclockwise, as shown in Figure C-2. To reassemble, insert the ball into its housing, replace the cover, and secure it by turning the cover in a clockwise direction.

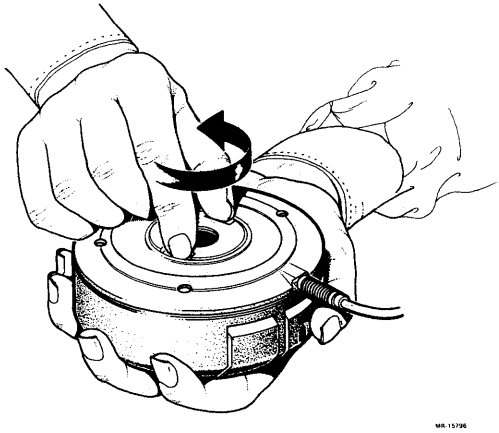

Figure C-2 Mouse Ball Removal

## C.3 USING THE MOUSE

The mouse is normally used in contact with a desktop, to the right or left of the keyboard. To operate the mouse, take hold of it and allow your index finger to rest lightly on its buttons. Its cable should lead away from you. Move the mouse on the desktop to verify that the cursor responds correctly: it should go left when the mouse is moved left; right when the mouse is moved right; up when the mouse is moved away from you; and down when the mouse is moved toward you.

By experimenting, each user will find the most comfortable method of holding and moving the mouse. The mouse buttons may be either pressed from the front or down from the top. Most users find it easiest to make small movements of the wrist. Note also that the mouse can be picked up and repositioned at any time.

The buttons on the mouse are commonly referred to as left (L), middle (M), and right (R), as shown in Figure C-1. The functions of the mouse buttons depend on the software used. (Refer to applicable software documentation.)

## C.4 MOUSE SPECIFICATIONS

PHYSICAL

| | |
|---|---|
| Size | 8.8 cm (3.5 in) diameter, 4.0 cm (1.6 in) high |
| Weight | 170 g (6 oz) including cable |
| Switches | Three tactile-type switches, actuating force approximately 85 g (3 oz) |
| Cable | 1.5 m (5 ft), round 0.375 cm (0.15 in) diameter, 6-conductor #26 AWG stranded, shielded high-flexibility design |
| Connector | 7-pin micro-DIN type (male) |
| Temperature | Operating: +10°C to +40°C (+50°F to +104°F) |
| | Nonoperating: -40°C to +66°C (-40°F to +150.8°F) |

ELECTRICAL

| | |
|---|---|
| Power | +5 Vdc +/- 5% at less than 150 mA<br>-8 V to -13 V at less than 20 mA |
| Interface | RS-232 voltage-level-compatible, output from the mouse capable of driving a load of 3 kilohms to ground (mark less than -6 V, space = 4.6 V min.) |
| FCC/EMI | Class B certified |

PERFORMANCE

| | |
|---|---|
| Resolution | 0.125 mm (200 counts per inch) |
| Tracking Speed | 0.76 m/s (30 in/s) |
| Accuracy | +/- 3% 0 - 25 cm/s (0 - 10 in/s),<br>+/- 15% 25 - 50 cm/s (10 - 20 in/s),<br>+/- 30% 50 - 75 cm/s (20 - 30 in/s) in any direction |
| Acceleration | 0.5 g (5 m/s/s) |

OPERATING

| | |
|---|---|
| Modes | Incremental Stream<br>Prompt (power-up default) |
| Report Format | Serial asynchronous (8 data bits, odd parity), report consists of 3 bytes indicating button state and relative displacement |
| Sampling Rate | 55 reports/s in incremental stream mode, up to 95 reports/s when polling |
| Baud Rate | 4800 baud |

### C.4.1 Signal/Power Cable

The connector wiring pin assignments and functions are listed in Table C-1.

The mouse cable male connector pins are numbered as shown in Figure C-3.

**Table C-1 Mouse Connector Pin Assignments/Functions**

| Pin Number | Function |
|---|---|
| 1 | GND (signal and power return) |
| 2 | TXD (serial out from mouse) |
| 3 | RXD (serial in to mouse) |
| 4 | -12 V |
| 5 | +5 V |
| 6 | Not used |
| 7 | Device present (shorted to pin 1) |
| Shell | Protective ground |

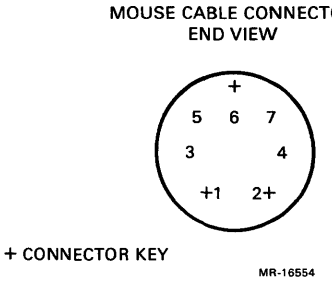


Figure C-3 Mouse Cable Connector Pin Numbering

### C.4.2 Spurious Outputs

The mouse is designed to avoid reporting movement when it is not tracking on a surface. Lifting the mouse from a horizontal surface will not report movement of more than 20 counts of resolution.

Noise problems are suppressed where the output varies by one count when the mouse is not being moved.

## C.5 ELECTRICAL INTERFACE

### C.5.1 Interface Signal Levels

The mouse transmits and receives RS-232-compatible signals.

Transmit: Mark < -6 V, space > 4.6 V
Receive: Mark -15 V to 0.8 V, space 2.8 V to +15 V

Minimum dc load resistance is 3000 ohms to ground.

### C.5.2 Power and Voltage Considerations

To operate, the mouse requires +5 V +/- 5% at 150 mA. On systems where a long extension cable is used between the mouse and its power supply, it may be necessary to regulate a higher voltage (5.2 V) at the system to overcome the voltage drop of the cable. Digital's local service representative should be consulted to determine the adequacy of the supplied voltage when adding a mouse extension cable.

There is no fuse inside the mouse housing due to its small size and low voltage requirements. If developing hardware to power the mouse, a fuse or other current-limiting method is recommended as a safety precaution.

The rise time of the +5 V supply should be less than 100 ms to ensure that power-up reset occurs.

## C.6 MOUSE OPERATION

### C.6.1 Serial Interface Operation

The mouse communicates with its host via an asynchronous, serial interface at 4800 baud (+/- 2%). Each character consists of one start bit, eight data bits, one parity bit (odd), and one stop bit. The mouse ignores incoming parity and the most significant bit of each byte (bit 7) on receive.

The mouse supports only half-duplex communication. If a byte is sent to the mouse while it is transmitting, the mouse will abort the data being transmitted (force a break) and process the new command immediately (except during self-test). If a byte is received between the characters of a multibyte report, the mouse is still considered to be transmitting and will abort the current report.

### C.6.2 Report Format

Data is transferred in 9-bit bytes (8 data, plus odd parity). Though the mouse transmits odd parity, it ignores parity errors on receive. The mouse transmits a 3-byte position report, as shown in Figure C-4.

The X and Y values in the mouse position report give the movement in units of resolution since the last report. If the X or Y values overflow, the maximum movement is reported.

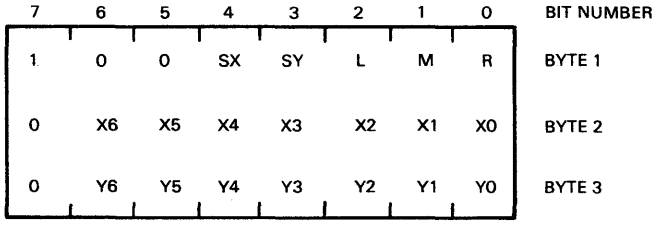


Figure C-4 Three-Byte Position Report Format

### C.6.3 Operating Modes

The mouse has two operating modes that determine when, and how often the mouse transmits a position report:

1. Incremental Stream Mode
2. Prompt Mode (power-up default).

In incremental stream mode, the mouse generates reports at 55 Hz intervals any time there is movement, or a change in button position since the last report. If the mouse is motionless and no buttons have changed, no report is generated. The report rate under continuous movement or button change is 55 reports/s.

In prompt mode, the mouse generates a report only in response to a request mouse position command. The mouse responds to over 95 position requests/s.

### C.6.4 Summary of Mouse Commands

All mouse commands are printable ASCII characters and are summarized in Table C-2. The mouse ignores invalid commands.

**Table C-2 Mouse Command Summary**

| ASCII | Hex | Function |
|---|---|---|
| R | 52 | Select incremental stream mode |
| D | 44 | Select prompt mode |
| P | 50 | Request mouse position -- The mouse responds with a position report. The P command also switches the mouse to prompt mode. |
| T | 54 | Self-test and identify -- The mouse responds with its self-test report (see Paragraph C.6.5). Self-test leaves the mouse in the reset or power-up state. When a self-test command is issued, it is invalid to send any data to the mouse until the last byte of the self-test report is received. The mouse ignores any data received during self-test. |
| Zx | 5A XX | Reserved functions for testing or quality control that are completed within one second. The previous mouse state is not disturbed. |

### C.6.5 Power-Up Self-Test and Identification

Upon command from the computer or mouse power-up, the mouse automatically checks its internal logic and circuits, and transmits a self-test report consisting of a 2-byte identification code and a 2-byte code describing the health of the electronics and firmware.

The 4-byte self-test report shown in Figure C-5 is transmitted at power-up.

The bytes shown in Figure C-5 are described below.

Byte 1, Firmware ID: Bit 7 through bit 5 (101) indicates the start of a self-test report. R3-R0 is the revision number.

Byte 2, Hardware ID: A single-byte code for manufacturing and device identification. M2-M0 is Digital's manufacturing location ID. Bit 3 through bit 0 is the device code; 0010 indicates mouse data. Figure C-6 shows the ID code format.

Manufacturing location ID assignments are reserved for Digital's future definition.

Device ID assignments:

0010 - Indicates mouse data
0100 - Indicates tablet data

Byte 3, Error Code or Zero: Error code ASCII ">" (3E hex) indicates a RAM or ROM checksum error. If there is no checksum error, ASCII "=" (3D hex) indicates a button error. Codes of 20 (hex) or greater are considered to be fatal hardware problems, codes less than 20 (hex) are nonfatal.

Byte 4, Button code or Zero: The code will be the same as the low three bits of of the first byte of the mouse position report, indicating which, if any, buttons are down or have failed.

Example: 04 (hex) would mean a left button error.

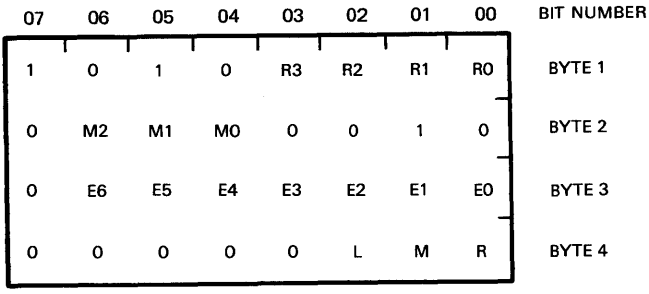


Figure C-5 Four-Byte Self-Test Report Format

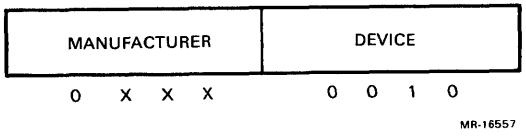


Figure C-6 ID Code Format

The switches in the mouse have two contacts, and thus, four possible states:

1. Button up
2. Button down
3. Both contacts open (switch missing)
4. Both contacts closed (short circuit).

The left and right switches report a button error for any state other than button up. The middle switch reports an error for button down, or both contacts closed.

The mouse ignores any data received during self-test until the last byte of the self-test report is transmitted.

### C.6.6 Report Synchronization

Bit 7 of the first byte of a multibyte report is 1, and can be used for software synchronization. Bit 7 of the succeeding bytes of a multibyte report are always 0s.

The following starting bit sequences are defined (bit 7, bit 6, and bit 5 of the first byte of a multibyte report).

100 - 3-byte relative position report (mouse)
101 - 4-byte self-test report (mouse or tablet)
110 - 5-byte absolute position report (tablet)
111 - Reserved for Digital's future definition

### C.6.7 Response Time

The mouse completes all valid commands, except self-test and Digital's reserved functions, within 50 ms. It processes a self-test command within 500 ms. At power-up, the mouse completes its self-test within 1 second from stable power.

## C.7 PROGRAMMING CONSIDERATIONS

Digital's serial mouse does not support the XON/XOFF flow control protocol because there is no data buffering inside the mouse. This results in a more effective link between mouse and cursor.

The serial mouse uses half-duplex communication. Half-duplex does not interfere with normal mouse operation because there is no reason to send a command to the mouse while it is transmitting. When polling, the previous 3-byte report is always read before requesting another report. The only other commands to the mouse cause it to reset or change operating modes.

The mouse powers up in prompt mode to avoid sending position reports to the host before it is ready to receive them. The mouse's self-test report is transmitted at power-up to notify the host of its presence.

### C.7.1 Initialization

Although Digital's serial mouse defaults to prompt mode at power-up, host software should select the protocol and operating mode explicitly for compatibility with other mouse devices. A complete power-up sequence typically includes the following steps.

1. Initialize the host's serial port for the mouse for 4800 baud (8 data, odd parity, 1 stop bit).

2. Read the power-up self-test report to confirm the mouse's identification and function. If the self-test was successful, go to step 4.

**NOTE**

**The self-test report may indicate the pointing device is a digitizing tablet. (See Appendix D.)**

3. If the self-test report is not received in 1 second:

   Check that the mouse is correctly attached and send ASCII T (54 hex) to invoke self-test. If the mouse responds, check identification and function. If there is no response, assume a defective or alien mouse.

4. Send ASCII S (53 hex) to select the report format. (Currently, there is only one format.)

5. Send ASCII R (52 hex) to select incremental stream mode, or ASCII D (44 hex) to select prompt mode (power-up default).

### C.7.2 Incremental Stream Mode vs. Prompt Mode

The mouse has two operating modes that determine when, and how often the mouse transmits a position report.

In incremental stream mode, the mouse tests for movement or button action 55 times/s, and sends a report only when a significant event occurs. This mode allows the host to track the cursor smoothly, with a minimum of data overhead.

An effective way to use incremental stream mode is to set the alarm level on the universal asynchronous receiver transmitter (UART) to interrupt only when its first-in/first-out (FIFO) buffer is full. On each vertical interrupt, the host polls the UART for available data. If data is waiting, the host reads the report and updates the cursor position. Otherwise, no action is necessary. The host rarely receives UART interrupts.

The mouse can also be polled to allow the host to control when the mouse position is updated. Since the buttons are not latched (only debounced), the host must poll frequently enough to detect any button action.

The intended use of polling is to synchronize mouse updates with video refresh in order to minimize interrupt overhead. On each vertical interrupt, the host reads the previous 3-byte report from the mouse UART, and then sends the command to poll the mouse. If the UART is buffered (as many are), allowing it to hold three bytes, the host never needs to respond to mouse interrupts.

To move the cursor absolutely smoothly under worst-case conditions, it is necessary to update the cursor position every frame time. For normal 60 Hz refresh, the 55 Hz sampling rate is sufficient to provide good tracking. For the smoothest possible tracking, or higher frame rates, polling at the frame refresh rate is recommended.

### C.7.3 Button Use

Mouse buttons are commonly referred to as left, middle, and right. The left button is frequently used for the "select" function, and most closely corresponds to the single button available on other mouse devices.

For 2-button applications, the recommended convention is to treat the right and middle buttons as identical. The left and right buttons are used for compatibility with 2-button documentation. The left and middle buttons are used for comfort and easy identification by touch.

### C.7.4 Tablet Support

By adding minor extensions to the mouse software, the mouse input port can accommodate Digital's serial tablet as well. For detailed information on the tablet, refer to Appendix D. With appropriate device drivers, it is possible to swap the mouse and tablet transparently while an application is in progress. The tablet uses the same connector and serial interface format as the mouse, and recognizes the same commands (with some additions to accommodate its extended capabilities).

The tablet's power-up self-test and identification sequence uses the same format as the mouse's, but some values differ. Device code 0100 is used to indicate tablet data. By convention, tablet error codes (byte 3 of the self-test report) indicate success for values less than 32 (20 hex), and error for values of 32 or greater.

The tablet transmits a 5-byte absolute position report, with the starting bit sequence 110 used for synchronization.

Since the tablet is an absolute pointing device, it is generally undesirable for applications to move the cursor away from the position last reported by the tablet. For compatibility with the tablet, applications may wish to avoid repositioning the cursor when using the mouse.

While the mouse has three buttons, the digitizing tablet can use either the 4-button puck or the 2-button stylus. The tablet puck has its buttons arranged in the form of a diamond. (See Appendix D.) By convention, puck button B1 relates to the mouse's left button, puck button B2 to the mouse's middle button, and puck button B3 to the mouse's right button. The tablet puck's button B4 is ignored. When using the 2-button stylus, the barrel button B1 corresponds to the mouse's left button, and the tip button B2 corresponds to the mouse's right button.