Accelerometer Mouse: Hardware Description

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**Introduction**

The accelerometer mouse is a wireless USB mouse that operates in midair. To move the cursor, a user needs only tilt the mouse in the desired direction. The accelerometer mouse has three mouse buttons a scrollwheel. The mouse design is comprised of two main units: a transmitter unit and a receiver unit. In this hardware description, an overview of both units is given in Figure 1, followed by a breakdown of the major components within each.

![Figure 1: Accelerometer Mouse Block Diagram](image)

**Transmitter Unit Components**

**MCU**

The transmitter unit design is based on Motorola’s MC9S12C32 16-bit Microcontroller. Besides availability of development tools, the C32 was selected for its small size, low cost, and low power consumption. The transmitter MCU is clocked with an 8MHz crystal, and operates at 4MHz (1/2 ECLK) to minimize power consumption. External
PLL circuitry is inexpensive, and is included for future functionality updates. Two of the C32’s timer channels are used to capture pulses from the accelerometer output. TxD from the MCU’s SCI sends tilt and switch status data to the RF transmitter module.

**Inputs**

The transmitter unit’s input section is comprised of the ADXL202E accelerometer and six switches. Configured to sense tilt, the accelerometer duty-cycle modulates two output pulse trains, sent to IOC0 and IOC1. The pulse train periods are determined by the value of R1. Power cycling is simplified by powering the accelerometer through a GPIO pin (PAD0), which is acceptable given the accelerometer’s low Idd(max) = 6mA.

S1, S2, and S3 are Omron N/O pushbutton switches, salvaged from a standard PS2 mouse. These three switches represent left-click (Mouse1), right-click (Mouse2), and wheel-click (Mouse 3) respectively. Salvaged from a different mouse, S4 and S5 are parts of a thumbwheel assembly, and represent forward and reverse wheel movement. S6 is a pushbutton toggle switch used to enable/disable cursor movement. Each switch is connected to an input pin on Port T, and pulled up by a 100k resistor.

**Power Supply**

Two AA batteries are used in conjunction with a synchronous boost converter (Texas Instruments UCC39412) to power the transmitter unit. The UCC39412 delivers a regulated 3.3V, and was designed for use in battery-powered handheld devices with high
efficiency requirements. Efficiency will be further optimized through power management software. Local capacitors decouple the converter’s input and output.

**Transmitter**

The Linx Tx-433-LC is a SAW-stabilized RF transmitter operating at 433MHz. All modulation/encoding is handled on-chip. The output from the transmitter is connected to a ¼ wave helical antenna, which fits inside the casing of the transmitter unit. The Tx-433-LC has a low maximum current draw (less than 6mA), and like the accelerometer, is powered by a GPIO pin for simple power cycling.

**Receiver Unit Components**

**MCU**

Again, the Motorola’s C32 was selected for its size, power consumption, and low cost. Another benefit is the C32’s on-chip low voltage reset, absent in early Star-12 variants such as the DP256. The receiver unit MCU is also clocked by an 8MHz crystal, but uses the PLL circuitry to run at 24MHz. Power from the USB port is cheap, so the extra processing speed will be used for digital filtering, and cursor smoothing/acceleration. After calculations, mouse reports will be generated at a rate of no less than 125Hz. The MCU’s SPI lines are used to mediate communication with the USB UART, which reads data from PT0-PT7.
USB UART

FTDI’s USB245M is used to painlessly convert parallel mouse data to USB format. Early iterations of the accelerometer mouse design used the USB245M’s serial counterpart, the USB232M. However, when the DP256 MCU was dropped for the C32, this left only one SCI, which is already used by the Linx receiver module. While the USB245’s connections are slightly more complicated, the prices of the two FTDI chips are identical. Additionally, the parallel chip is capable of much faster data transfers than the serial version. Connected to the UART, U4 is a serial EEPROM, which stores programmable PID/VID strings, allowing the operating system to identify and match drivers to the accelerometer mouse.

Power Supply

Efficiency is not as critical in the receiver unit as in the transmitter. Thus, the LM1086-3.3V fixed regulator is chosen for its low price and simplicity. The regulator will be supplied by +5V from the USB power bus. Local capacitors are placed across the input and output of the regulator. The diode D1 protects the regulator from damage due to rapid capacitor discharge, in the event that the Vin is suddenly grounded.

Receiver

The Linx Rx-433-LC-S is a very simple receiver solution, and is designed to be paired with the transmitter unit’s Tx-433-LC. The receiver module uses a ¼ wave whip antenna, which is mounted externally on the receiver unit case.