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Objectives

For our project, we are creating a wired keyboard that will be compatible with Windows computers. The functional description, roles and responsibilities, and deliverables are detailed below.

Roles and Responsibilities: The project work will be divided in the following manner:

i) Matija – PCB
ii) Eric – Enclosure
iii) Jenna – LCD mini-apps and other drivers
iv) April – USB and Bluetooth communication and MX Switch Matrix

Interactions with Existing Systems: Our keyboard will be a functional wired keyboard for use with Windows computers.

Functional Description

a) Functionality: Our system will act as a functioning USB keyboard. When a key on our keyboard is pressed, the computer it is connected to will type (display) the key. We will also attempt to implement Bluetooth functionality, such that the keyboard can also function wirelessly.
b) Performance: We will judge that our keyboard has proper functionality if we are able to quickly and accurately type using the keyboard. Our keyboard will need to respond to keystrokes at 500 words per minute with near 100% accuracy.
c) Usability: The keyboard will function as a normal keyboard. We will have letter keys, number keys, and caps, tab, shift, and control keys. Four letter keys will also have alternate functions as arrow keys. Essentially, we will be building a 60% size keyboard.

Deliverables

a) Reports: The reports for Labs 7 and 11 will be written

b) Outcomes: We will include the Lab 7 and Lab 11 deliverables

Hardware Design

See KiCad schematic and layout on GitHub.

Software Design

See code files on GitHub.

Measurement Data

a. See the BoM (excel file) on GitHub for specific details, however, the total cost estimate for all major components is $106.60, including the PCB manufacturing.
b. Estimated power:
    i. Keypad: ~0mA since it's just switches being pulsed for microseconds
    ii. LCD: maximum 50mA
    iii. Bluetooth chip (BGM220PC22HNA2R): 4.8mA idle and 10.8mA active
    iv. TM4C MCU: 34mA
    v. Power switching IC (TPS2113ADRBR): 0.5 uA in standby and 55 uA in active mode.

Total = 94.8 mA

c. Since we have a switching IC that switches between 4.5V (supplied by 3xAA batteries) and 5V VBUS (supplied by USB), the LDO regulator (TPS73633DBV) will, on average, consume P = VI = 4.75V * 94.8 mA = 450.3 mW

Analysis and Discussion Questions

1. How did you debug your system? How intrusive was it?

Debugging was a trip through the 9 circles of hell accompanied by the worst tour guide ever. It took me literal hours to remember PF0 has a default ON pull-up resistor and then a few more hours until I realized that I had Rx to Rx and Tx to Tx. In general, the debugging techniques were quite intrusive because I successively disabled parts of the code to determine issues, but I was able to slightly debug non-intrusively by using a scope/logic analyzer to observe the UART communication

2. What's the difference between unit testing, integration testing, and functional testing?

In general, unit testing checks individual units in isolation, integration testing verifies the interaction between these units, and functional testing ensures the overall system functions correctly according to the intended requirements. All these testing types play crucial roles in ensuring software/hardware quality and reliability.

Extra Credit

1. Eric Wang has completed 3-D printing training in the Texas Invention Works space. Matija Jankovic has also completed laser cutting training on the 7th floor of EER.
2. We use a TM4C123 QFN chip in our design, with the symbol, footprint, and model added. See the KiCad schematic and layout on GitHub for reference.