Electrical Overview

Year: 2025 Semester: Spring Team: 20 Project: Encrypted USB Drive

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1.0 Electrical Overview

The main processing unit will be the 32-bit STM32 microcontroller. This microcontroller will manage communication with a fingerprint sensor, keypad, LCD display, 4 flash chips, and a host computer. The microcontroller will communicate with the fingerprint sensor using UART. The fingerprint sensor does all the fingerprint storage and verification, so the microcontroller only needs to send commands to the fingerprint sensor to save and verify fingerprints. The microcontroller will communicate with the keypad using GPIO. The microcontroller will use a timer to poll each keypad row and read the keypad columns. The microcontroller will communicate with the LCD display using SPI. The LCD display will be used to convey the specific mode the user is in (see the website homepage for the state transition diagram). The microcontroller will communicate with the flash chips using SPI. Each flash chip will store a specific user’s data. We plan to use only one SPI bus to communicate with all 4 of these chips and just use the chip select line to determine which flash chip we’re communicating with. The microcontroller will communicate with the host computer using USB.

2.0 Electrical Considerations

Operating Frequencies

We plan to use USB full-speed, which is 12Mbps. Thus, we need to select a crystal that is at least 12MHz. We will use a 48MHz crystal as the clock for our microcontroller since that’s within the 4-50MHz specification for our microcontroller, and we used that frequency in ECE 362 and it worked.

We will poll the keypad at 1kHz because that’s what we did in ECE 362 and it worked.

Operating Voltage Level

We will input 5V from the USB connector, but we will pass it through a voltage regulator and use 3.3V to power everything. That includes the microcontroller, fingerprint sensor, LCD display, and flash chips. The device should work with an input voltage anywhere between 4.75V to 5.25V since that’s what the USB spec allows.

Power Consumption Calculation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Component | Function | Qty | Avg Current (mA) | Power at 3.3V (mW) | Datasheet References |
| STM32H7A3RGTx | MCU | 1 | 40 | 132 | [2] |
| Adafruit 419 | Keypad | 1 | 2 | 6.6 | [4] |
| MT29F4G01ABAFDWB | Flash | 4 | 40 | 132 | [5] |
| SEH1602-A | LCD Display | 1 | 31 | 102 | [1] |
| GROW R502-A | Fingerprint Sensor | 1 | 20 | 66 | [3] |

Total current: 233mA

Total power (at 5V): 1.2W

Our voltage regulator can support up to 1A of current draw so we’re good. [6]

3.0 Interface Considerations

|  |  |  |
| --- | --- | --- |
| Device | Serial Interface | Data Rate |
| Fingerprint Sensor | UART | 19200 bps |
| Host Computer | USB | 12 Mbps |
| Keypad | STM32’s timer | 1 kHz |
| Flash | SPI | 24 Mbps |
| LCD Display | SPI | 500 Kbps |

4.0 Sources Cited:

[1]“Dot matrix OLED display module Manual 1602A -OLED.” Accessed: Feb. 09, 2025. [Online]. Available: <https://www.technologicalarts.ca/support/docs/Components/OLED1602A/SOC1602A.pdf>

[2]STMicroelectronics, “Features Includes ST state-of-the-art patented technology Core • 32-bit Arm ® Cortex ® -M7 core with double-precision FPU and L1 cache,” May 2022. Accessed: Feb. 09, 2025. [Online]. Available: <https://engineering.purdue.edu/477grp20/Files/refs/stm32h7a3ai.pdf>

[3]Hangzhou Grow Technology, “R502-A Fingerprint Module,” Sep. 2023. Accessed: Feb. 09, 2025. [Online]. Available: <https://engineering.purdue.edu/477grp20/Files/refs/R502-A%20fingerprint%20module%20user%20manual-V1.3.1.pdf>

[4]Adafruit, “Membrane 3x4 Matrix Keypad + extras -3x4,” Sep. 2022. Accessed: Feb. 09, 2025. [Online]. Available: <https://mm.digikey.com/Volume0/opasdata/d220001/medias/docus/1267/419_Web.pdf>

[5]Micron, “Universal Page,” https://twitter.com/MicronTech, 2023. <https://www.micron.com/content/dam/micron/global/secure/products/data-sheet/nand-flash/70-series/m70a-4gb-3v-nand-spi.pdf> (accessed Feb. 09, 2025).

[6] Diodes Incorporated, “Az1117i,” Diodes Incorporated, <https://www.diodes.com/assets/Datasheets/AZ1117I.pdf> (accessed Feb. 9, 2025).

Appendix 1: System Block Diagram

*A diagram of a circuit board

AI-generated content may be incorrect.*