Final Project Proposal

Year: 2025 Semester: Spring Team: 15 Project: αCassiopeiae 8800

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Team Members (#1 is Team Leader):

Member 1: Seth Deegan Email: [sdeegan@purdue.edu](mailto:sdeegan@purdue.edu)

Member 2: Brian Lu Email: [lu964@purdue.edu](mailto:lu964@purdue.edu)

Member 3: Caleb Shinkle Email: [cshinkle@purdue.edu](mailto:cshinkle@purdue.edu)

Member 4: Nathan Huang Email: [huan1811@purdue.edu](mailto:huan1811@purdue.edu)

1.0 Project Functional Description:

We plan to create a miniaturized version of the Altair 8800, one of the first microcomputers [2]. Our product is designed to appeal to hobbyists and educators interested in low-level computer programming, targeting these specific markets. Unlike other Altair 8800 clones and low-level programming interfaces, our product stands out by offering a compact, portable, and physical interface that authentically represents early computer technology. Furthermore, it supports ongoing learning through the potential for expansion cards and software development.

The replica will aim to maintain the functional structure of the original computer which includes an enclosure that has a front panel with switches and LEDs as a programming interface, and individual CPU and memory cards that will slot into a common backplane, which acts as an 8080-derived bus in the vein of the S-100 [1]. We will utilize the RP2350B microcontroller to emulate the functionality of the original Intel 8080 processor on the CPU card. If time permits, a UART card will be developed to enable our computer to do high speed serial interfacing. Our team will be designing each of the front, backplane, and card PCBs; the interfaces for the S-100 bus; a buck converter for power delivery; and software to emulate the Intel 8080.

2.0 Team Member Expertise and Team Roles and Responsibilities:

2.1 Team Member Expertise:

2.1.1 Team Member: Seth Deegan: Has done light electronics work in introductory engineering courses with STM32, ESP32, and utilizing PlatformIO. Expertise in software development and digital design. Has experience with multiple programming languages and is open to learning and using others. Verilog experience.

2.1.2 Team Member: Brian Lu: ESP32, STM32 programming. Layout and routing for STM32F0 (KiCAD, Altium). SystemVerilog experience. Comfortable with software (C/C++/Rust/Python/etc. and mechanical design (OpenSCAD, Professional Suites, KiCAD).

2.1.3 Team Member: Caleb Shinkle: Light experience programming STM32 microcontrollers in a microcontroller systems course (ECE 362), experience with hardware verification in SystemVerilog, including ASIC and CPU design through ECE 337 and ECE 437. Comfortable with several programming languages including C, C++, and Python.

2.1.4 Team Member: Nathan Huang: Heavy experience with microcontroller programming, including Raspberry Pi, Arduino, ESP32, and STM 32 through PlatformIO. Mild experience in software programming and development, and knowledge in hardware verification and HDL through ECE 337 and as a teaching assistant for ECE 270 for 4 semesters. I had a Co-Op for a semester where the focus was mainly on PCB Design.

2.2 Team Roles and Responsibilities:

|  |  |
| --- | --- |
| Role | Team Member |
| Team Lead | Seth Deegan |
| Systems Lead | Brian Lu |
| Hardware Lead | Nathan Huang |
| Software Lead | Caleb Shinkle |

3.0 Homework Assignment Responsibilities

|  |  |  |  |
| --- | --- | --- | --- |
| *Design Component Report* | | *Professional Component Report* | |
| A3-Software Overview | Caleb Shinkle | A9-Legal Analysis | Seth Deegan |
| A4-Electrical Overview | Nathan Huang | A10-Reliability and Safety Analysis | Nathan Huang |
| A6-Mechanical Overview | Brian Lu | A11-Ethical/Environmental Analysis | Caleb Shinkle |
| A8-Software Formalization | Seth Deegan | A12-User Manual | Brian Lu |

4.0 Estimated Budget

1. Development
   1. Stamp XL x3: $19 x 3 = $57
2. Production
   1. Case x2
      1. Rear plates (if applicable) $10 budget
      2. Enclosure - $50 Maximum per enclosure
   2. PCB
      1. Switches (Tactile buttons, Slide switches) – $5
      2. LEDs - $13.74 x 2 = $27.48
      3. RP2350B - $5 x 3 = $15
      4. Buck converter components
         1. Step Down Chip (ACT4088US-T) $0.60 x 3 = $1.80
         2. Surface Mounted Resistors = $5 Maximum
         3. Capacitors + Inductors = $3 Maximum
      5. Connectors (Edge Board, FFC) $1.50 x 16 + $1 x 16 = $40
      6. Miscellaneous Cost (PCB Printing) = $40
3. Total Cost: $254.28

5.0 Project Specific Design Requirements

* *PSDR #1: (Software) An ability to emulate the Intel 8080 processor as a device with internal states, and which is tied to the external clock/single-step on the 8080-bus.*
* *PSDR #2: (Hardware) An ability to communicate via edge board connectors 8080 bus and bus control signals between various board on the backplane, implemented via RP2350 PIO (Programmable I/O).*
* *PSDR #3: (Hardware) An ability to communicate 8080 bus, bus control, and CPU to front panel specific signals between the front panel and backplane. Because of the additional front panel signals, the connector must support more signals.*
* *PSDR #4: (Hardware) An ability to interface with the user via front panel display (red LEDs) and switches (slide switches and tactile buttons), allowing the user to control the clock/single-step and 8080 bus signals.*
* *PSDR #5: (Hardware) An ability for the front panel to provide edge-aligned clock signals up to 2 MHz, and debounced single-stepping signals to the 8080 bus.*
* *Stretch PSDR: (Hardware) An ability to perform serial bi-directional communication via an additional UART card, allowing for the use of monitor programs such as Microsoft BASIC.*
* *Stretch PSDR: (Hardware) An ability to receive power via USB using the USB-PD (Power Delivery) protocol.*

6.0 Sources Cited:

[1] “S-100 bus pin description,” S100 computers, http://s100computers.com/S100%20Bus%20Pins.htm (accessed Jan. 18, 2025).

[2] “altair 8800,” DAVES OLD COMPUTERS, http://dunfield.classiccmp.org/altair/index.htm (accessed Jan. 18, 2025).