A12 - User Manual

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

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Assignment Evaluation: See the Rubric in the Brightspace Assignment

1. Product Description  
   Step back in time and experience the dawn of personal computing with the αCassiopeiae 8800! This meticulously crafted device is a miniaturized, modern tribute to the legendary Altair 8800 microcomputer. Designed for retrocomputing enthusiasts, hobbyists, and educational explorers, the αCassiopeiae 8800 offers an authentic hands-on experience with the iconic front panel interface – toggle switches, blinking LEDs, and all. Built with modern components like the Raspberry Pi RP2350B microcontroller, it faithfully emulates the Intel 8080 processor, allowing you to run classic software like 4K BASIC. Its modular design features a backplane system with expansion slots, inviting you to customize and enhance its capabilities, perhaps even adding UART communication. Powered by a standard USB-C connection and housed in a sleek aluminum enclosure, the αCassiopeiae 8800 blends vintage charm with modern convenience. Relive computing history or discover the fundamentals from the ground up with this unique and engaging microcomputer.
2. Product Illustrations

A close up of a computer chip

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A computer generated image of a green electronic device

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1. Setup Instructions

Unpack: Carefully remove the αCassiopeiae 8800 unit and the USB-C power supply from the packaging.

Card Installation (if separate):

* Ensure the unit is powered off.
* Identify the CPU and RAM cards (they share a PCB design but have different firmware).
* Align a card with an empty DDR4 DIMM slot on the internal backplane PCB.

A computer chip with a few components

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* Gently but firmly press the card down into the slot until the retention clips on the sides of the slot snap into place.
* Repeat for the other essential card(s).
* (Optional) Install any desired expansion cards (e.g., UART card) into available slots using the same method.

Front Panel Connection (if separate): Ensure the Flat Flex Cables (FFCs) connecting the Front Panel PCB to the Backplane PCB are securely seated in their connectors.

Connect Power: Plug the USB-C power supply into the USB-C port located on the backplane (accessible from the rear of the enclosure).

Plug In: Connect the power supply to a suitable wall outlet.

Power On: Locate the ON/OFF toggle switch on the front panel (see Section 4.0) and switch it to the ON position. The device should power up

A green board with red buttons and switches

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1. Usage Instructions

A close-up of a green electronic device

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The primary interaction with the αCassiopeiae 8800 is through its front panel.

Powering On/Off: Use the main toggle switch labeled "ON/OFF"

Understanding LEDs: The front panel displays system status via LEDs:

Status LEDs: Indicate CPU states like Interrupt Enable (INTE), Memory Read (MEMR), Halt Acknowledge (HLTA), etc.

Address LEDs (A0-A15): Show the current 16-bit address on the bus

Data LEDs (D0-D7): Show the current 8-bit data on the

Using Toggle Switches (Address/Data Input):

The row of 16 toggle switches (labeled 0-15) is used to set address and data values

Typically, the upper 8 switches (8-15) set the high byte of an address or data, and the lower 8 switches (0-7) set the low byte. Set the desired binary value by flipping switches up (1) or down (0).

Using Momentary Switches (Control): These switches trigger actions when pressed (often toggled up or down from a center-off position, implemented here with pairs of tactile buttons). Key functions include:

STOP/RUN: Halts or starts CPU execution

SINGLE STEP: Executes one instruction cycle per press

EXAMINE / EXAMINE NEXT: Loads the address set by the toggle switches into the Program Counter (EXAMINE) or increments the Program Counter and displays the memory contents at that address (EXAMINE NEXT)

DEPOSIT / DEPOSIT NEXT: Writes the data set by the toggle switches to the address currently in the Program Counter (DEPOSIT) or increments the Program Counter after depositing (DEPOSIT NEXT)

RESET / CLR: Resets the CPU or clears registers/flags

(Refer to specific Altair 8080 documentation for detailed operational procedures for programming via the front panel).

Maintenance - Loading Firmware:

The firmware for the RP2350B microcontrollers on the cards (CPU, RAM, Front Panel, Expansion) can be updated.

Each card features an internal USB-C connector. Connect a USB cable from a computer to this internal port while holding the BOOT button (if present, or follow RP2350B UF2 procedures) to enter UF2 bootloader mode. Drag the new firmware file (.uf2) onto the drive that appears.

Alternatively, firmware can be loaded using an external programmer via the SWD connector present on each card

Maintenance - Adding/Removing Expansion Cards:

Power off the unit and disconnect the power supply.

Carefully open the enclosure if necessary to access the backplane.

To remove a card, gently push the retention clips on the sides of the DDR4 DIMM slot outwards, and the card should pop up slightly. Lift the card out.

To add a card, follow Step 2 of the Setup Instructions.

1. Troubleshooting Instructions

| Issue | Probable Cause(s) | Suggested Solution(s) |
| --- | --- | --- |
| Device does not power on | Power supply not connected; Power switch OFF; Internal power regulation failure. | Ensure USB-C power supply is securely plugged into the unit and wall outlet; Verify front panel ON/OFF switch is ON; Check internal 3.3V regulator on backplane (Requires opening enclosure - advanced users only). Contact support if needed. |
| Firmware flashing fails (UF2 or SWD) | Incorrect boot mode; Faulty USB cable; Incorrect SWD wiring; Hardware issue (QSPI). | Ensure device is correctly put into UF2 bootloader mode; Try a different USB cable; Verify SWD programmer wiring; Advanced: Check for QSPI flash chip wiring. Contact support. |
| Front panel switches unresponsive | Firmware issue; Faulty I/O expander; Poor connection. | Reflash Front Panel firmware; Advanced: Check connections between switches and I/O expanders, and I2C connection between expanders and MCU. Contact support. |
| System crashes or behaves erratically | Firmware bug; Hardware instability (power, signal integrity); Overheating. | Ensure adequate ventilation; Try reflashing firmware for all cards; Advanced: Check for power supply stability or potential solder bridges on backplane/cards. Contact support. |
| Expansion card not working | Card not seated properly; Firmware issue; Bus conflict. | Reseat the expansion card firmly in its DIMM slot; Ensure correct firmware is loaded onto the expansion card; Verify no bus conflicts with other cards. |
| Physical assembly issues (e.g., tight fit) | Component misalignment; Incorrect component choice; Enclosure tolerance. | Ensure PCBs are correctly aligned within enclosure guides; Verify correct components were used during assembly (e.g., diode orientation per Week 12, Entry 2). |