RockSat-X 2025 Relay and Sensor System Overview

System Summary

This system is designed to support the RockSat-X 2025 flight mission. It consists of two primary custom PCBs:

1. **Relay Board (Power Distribution and IO Hub)**
2. **Sensor Board (Environmental Monitoring and Data Acquisition)**

The **Raspberry Pi 4** serves as the flight computer, handling mission logic and telemetry. Two **Raspberry Pi Picos** are dedicated to reading all sensor data. The system is enclosed in a sealed payload structure, with external devices interfaced through a hermetic DB-25 connector.

Power Architecture

Primary Power Input:

- A 28V DC line is provided by Wallops via GSE/TE.
- This line enters the Relay Board through a dedicated 2-pin header (J_PWR_IN_WLPS).

Voltage Regulation and Power Rails:

- The Relay Board hosts two buck converters:
    - One outputs 5V (via J_Buck_OUT_2) for the stepper motor and camera
    - One outputs 3.3V (via J_Buck_OUT_1) for the sensor board and logic

Distribution:

- Regulated 5V and 3.3V rails are distributed to the internal systems.
- A 3.3V line also routes through the DB-25 to power the external sensors.

Indicators:

- LEDs are included to confirm proper 3.3V and 5V rail operation during system testing.

Sensor Board: Environmental Data Acquisition

Sensors:

- **Internal (shielded on PCB):**
    - 1x BMP388 Pressure Sensor
    - 1x MMA8451 Accelerometer
    - 1x L3GD20 Gyroscope
- **External (wired via DB-25):**
    - 4x BMP388 Thermistors
    - 2x RadSense Geiger Counters

Sensor Power and Filtering:

- The sensor board receives 3.3V from the relay board.
- External sensors receive 3.3V power routed from the sensor board through the DB-25.
- All sensors (internal and external) are filtered with decoupling capacitors and proper pull-ups.

Signal Routing:

- External sensor **signal lines return** through the DB-25 connector directly into the sensor board.
- These lines are handled solely by the two **Raspberry Pi Picos**.
- The Relay Board is **not involved** in any external sensor signal routing.

Microcontroller Communication:

- The two Picos independently manage I2C buses and GPIO for all sensors.
- Each Pico is connected to the Raspberry Pi 4 over **USB**.
    - USB provides both **power and serial communication**.
    - There is no electrical connection between the Picos and the relay board.

Relay Board: Peripheral Power and Signal Routing

Functions:

- Accepts 28V input and regulates it to 5V and 3.3V

- Provides filtered and labeled outputs for camera power, stepper motor power, and general logic
- Routes signal lines to/from the Pi 4 for UART (camera), interrupts, and RS-232

Stepper Motor and Camera:

- The stepper motor is located **outside** the enclosure; only power is routed through the DB-25.
- The **ULN2003 stepper motor driver** is mounted and shielded **on the relay board**.
- The external camera's UART lines (TX/RX) and power also route through the relay board and then out the DB-25.
- The camera's UART is routed to **GPIO0 (pin 27)** for TX and **GPIO1 (pin 28)** for RX to avoid conflict with telemetry on GPIO14.

Protection:

- All signal lines exiting the board are routed through 100Ω resistors for basic EMI protection.

Hermetic DB-25 Connector

A hermetic DB-25 connector is mounted on the sealed payload wall. It acts as the single pass-through for all external connections. Each relevant power and signal wire is manually routed from the appropriate onboard connector (on the relay board or sensor board) directly to the correct DB-25 pin.

All wiring is secured, labeled, and potted per RockSat-X standards.

RS-232 Telemetry to Wallops

Telemetry Path:

- Raspberry Pi 4 UART0 TX (**GPIO14, pin 8**) is reserved for telemetry to Wallops
- Routed through a 100Ω resistor directly to a DB-25 pin
- Transmits telemetry at 19,200 baud
- Ground return included

Grounding and System Protection

- All subsystems share a unified ground referenced through the DB-25
- Input filtering is provided with bulk electrolytic and ceramic capacitors
- All I2C lines have onboard pull-up resistors
- Sensitive signal lines are protected with series resistors

Final Notes

- The relay board centralizes power and handles IO critical to motor and camera systems
- The sensor board independently manages both internal and external environmental sensors
- External sensors are powered by and report directly to the sensor board
- The Pi 4 and Picos communicate over USB and do not share data lines with the relay board
- The hermetic DB-25 is the sole interface for all off-board devices, with all wires manually routed from board connectors to the DB-25

This design ensures clean modularity, EMI protection, and reliable integration for a space-rated experiment platform.