UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

AdheraScent

Electrical & Computer Engineering

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April 2026

Agenda

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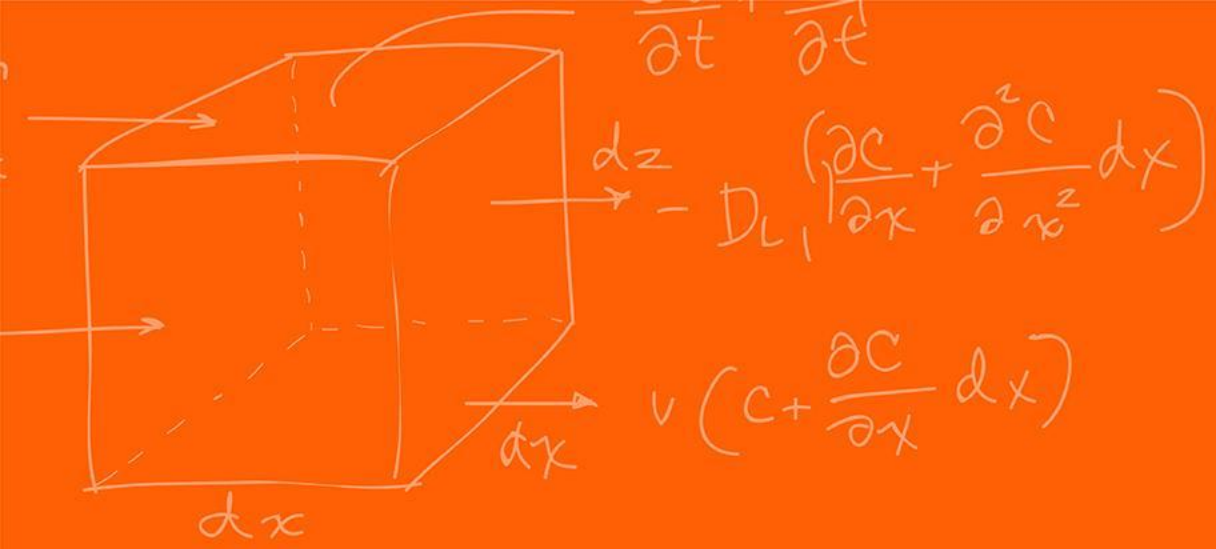
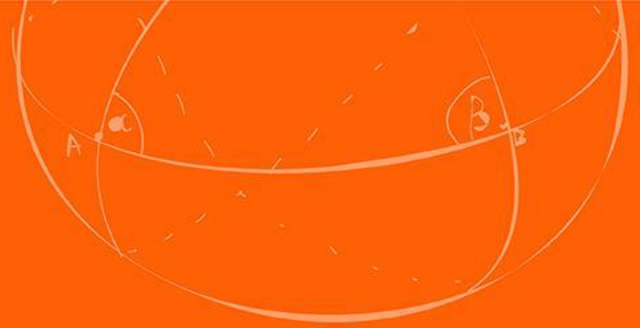
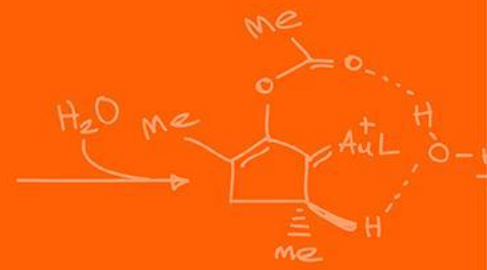
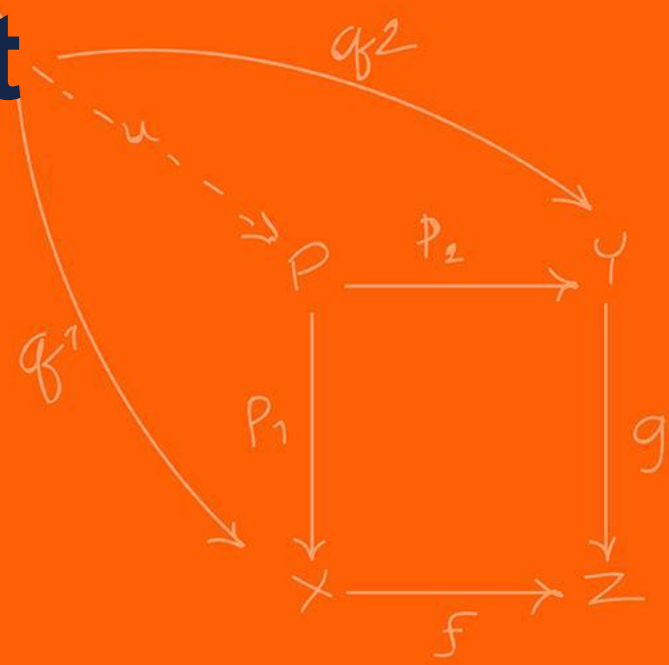






Problem Statement



The Problem: A Silent Epidemic

50 %

of chronic-condition patients fail their prescribed plan

125 K

preventable deaths/year from missed doses in the U.S.

$300 B

annual U.S. healthcare cost from non-adherence

62%

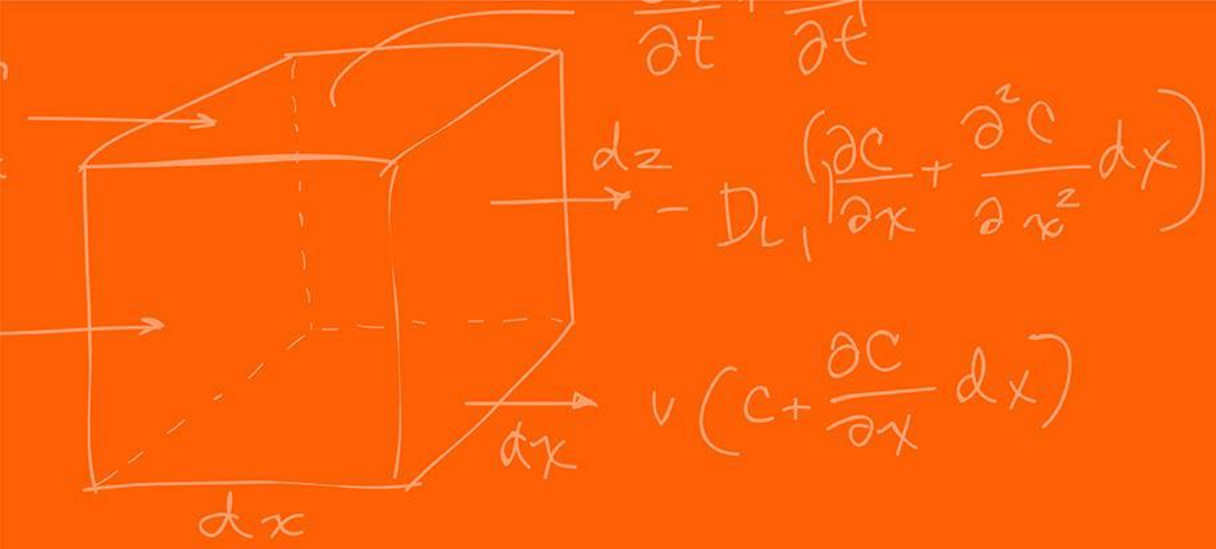
of non-adherent patients cite forgetfulness as the cause

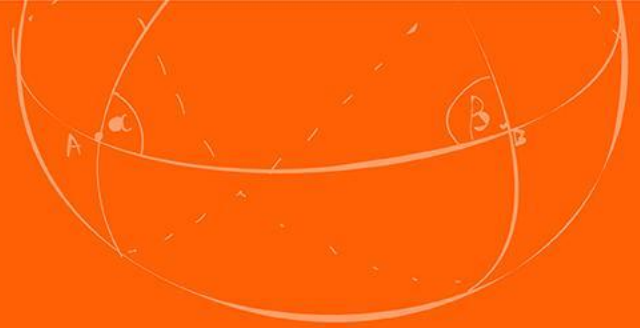
The Engineering Challenge

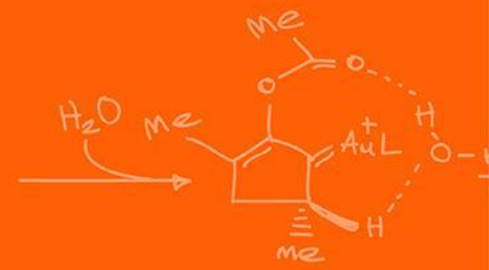
Design a device that is:

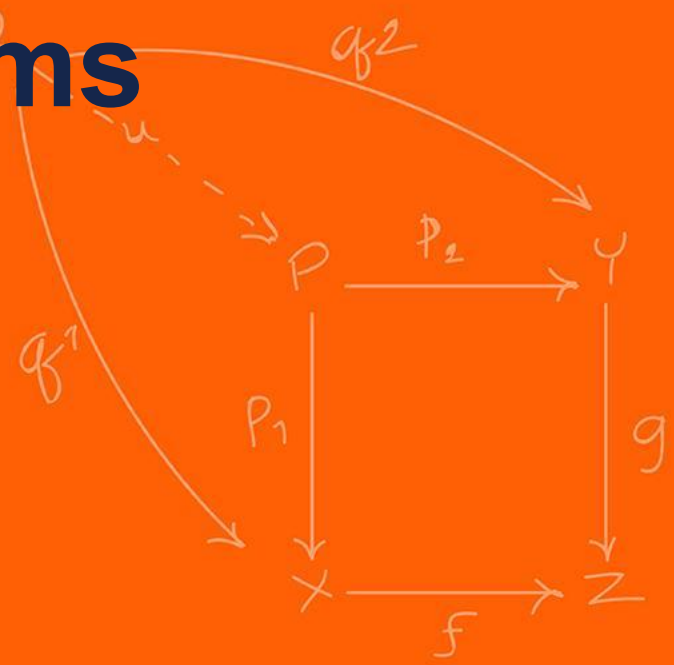
- Independent of smartphones
- Physically present in the environment
- Difficult to ignore
- Safe for medication storage

Solution & Subsystems









Solution: AdheraScent

A standalone, battery powered 3-day pillbox that reminds users to take their medication through scent without any external devices.

(1) Schedule

The real-time clock module tracks the real time and compares against the set medication window.

(2) Detect

Use reed switches and magnets to determine when the compartment has been opened.

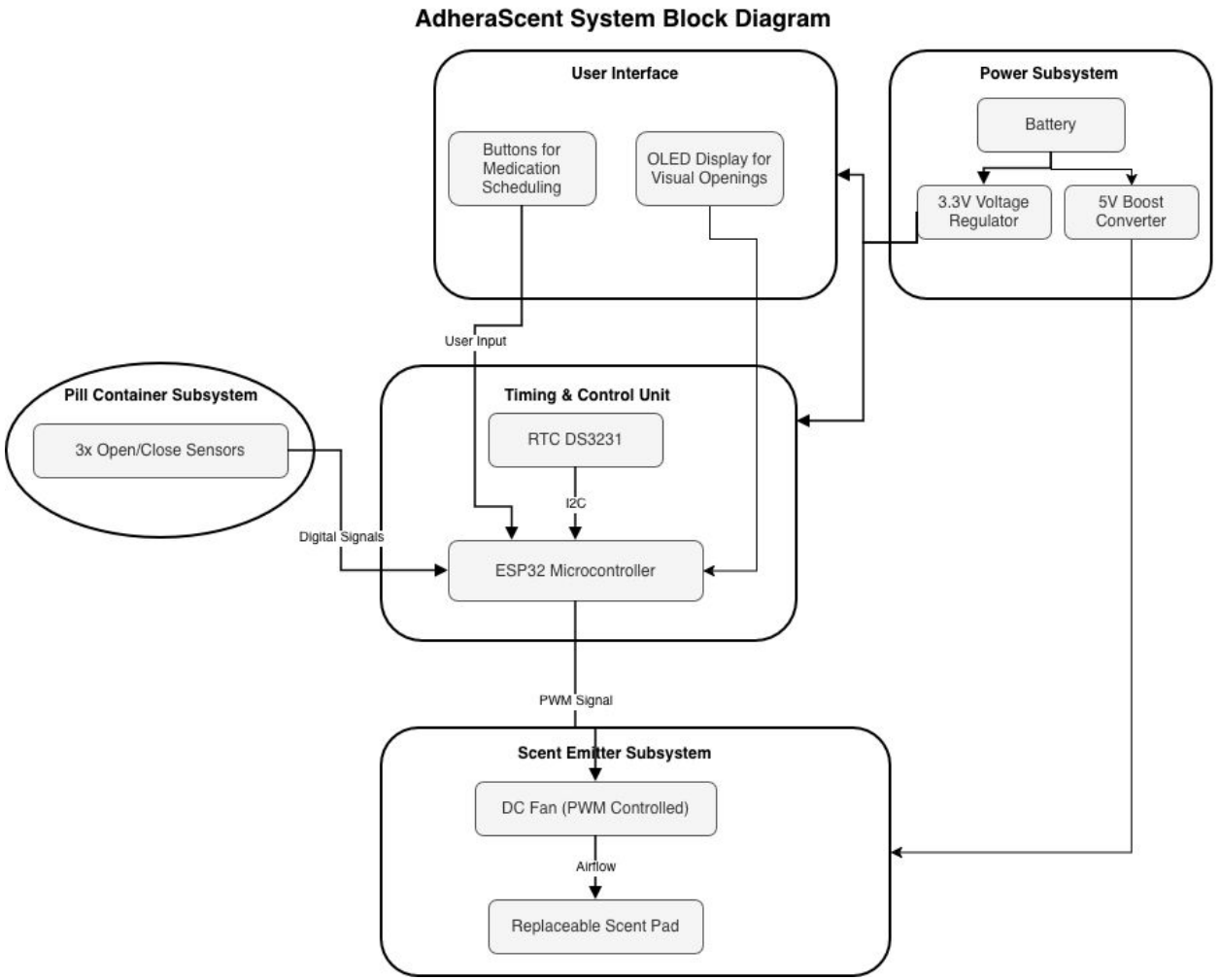
(3) Remind

If the medication window has passed, the DC fan will turn on to emit the smell.

(4) Stop

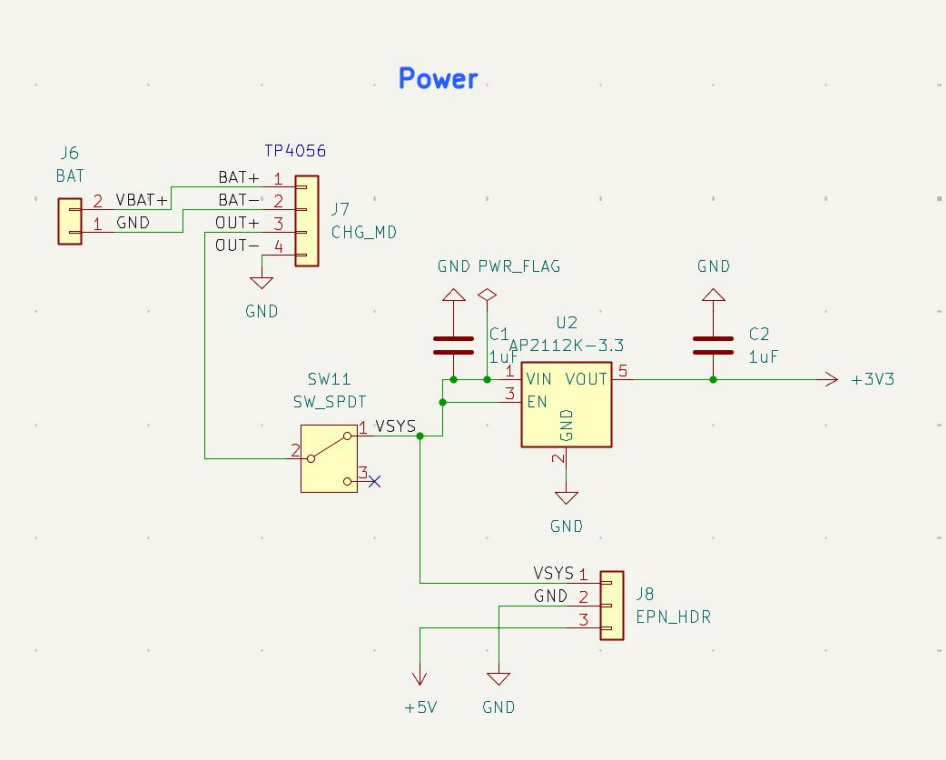
Once the compartment has been opened, the fan will stop.

Block Diagram - 5 Integrated Subsystems



Circuit Design & PCB

Power Subsystem - Design Requirements & Verification

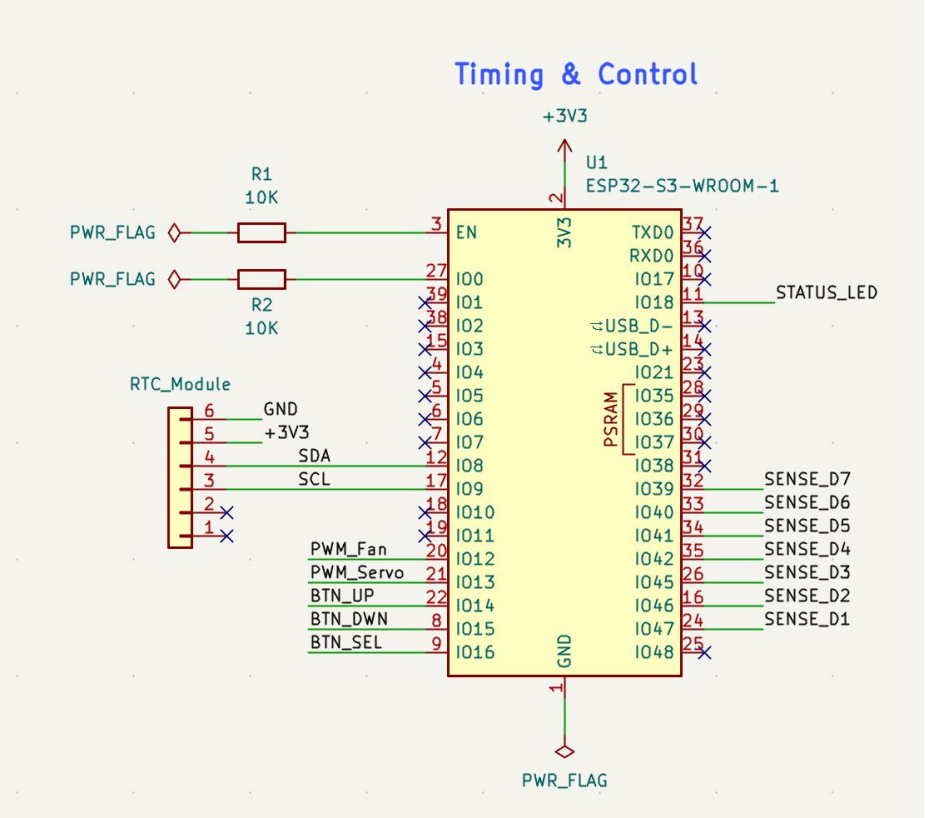


Design: Dual-rail power architecture using high-efficiency LDOs for 3.3V logic and a dedicated 5V rail for fan operation, integrated with a master physical kill-switch.

Verification Highlights:

- **Rail Regulation:** Verified 3.3V logic rail maintained 3.135V−3.465V and 5V fan rail maintained 4.75V−5.25V under full operational load.
- **Isolation Integrity:** Measured voltage at regulator input and logic rails with master switch "OFF," confirming leakage was below 0.1V.

Timing & Control Subsystem - Design Requirements & Verification



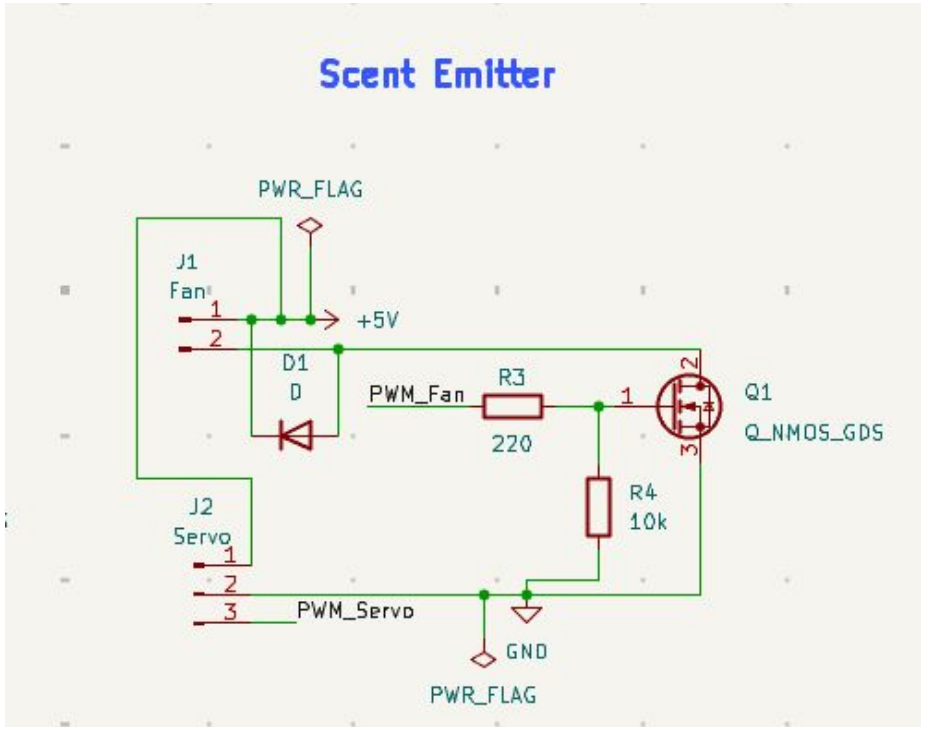
Design: * DS3231 High-Precision RTC for timekeeping (I2C).

- Finite State Machine (FSM) managing **INIT, NORMAL, and EDIT** modes.

Verification Results:

- **Accuracy:** Verified drift of **< 2ppm** (verified against reference clock).
- **Persistence:** RTC battery backup maintains time during main power interruption.
- **Cycle Logic:** Verified 100% success rate in automatic 3-day rollover (Day 3 → Day 1).

Scent Emitter Subsystem - Design Requirements & Verification



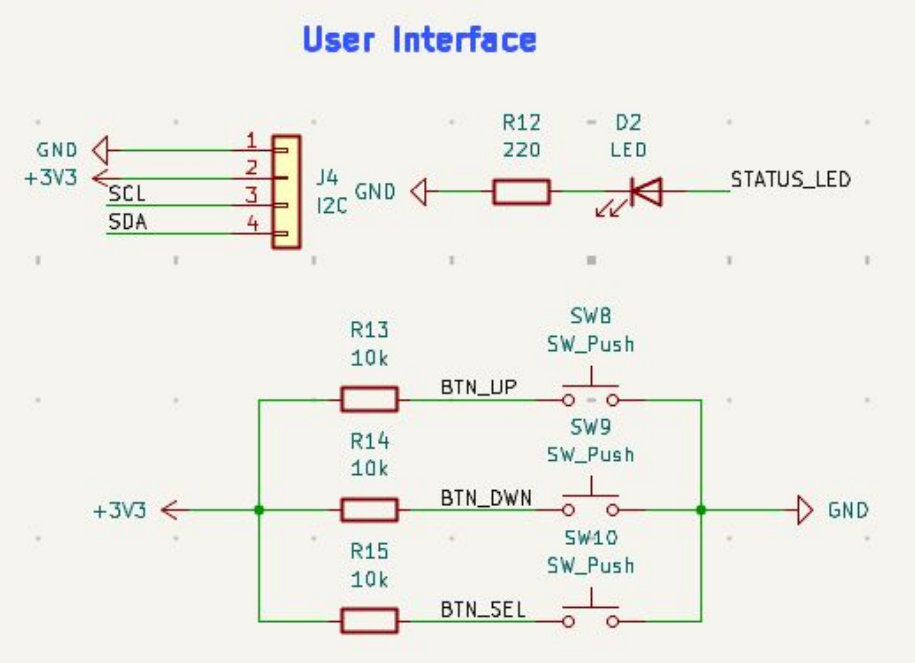
Design: * N-Channel MOSFET (low-side switch) driving a 5V DC fan.

- PWM-controlled dispersal intensity via ESP32-S3.

Verification Results:

- **Reach:** Scent detectable within a 1m radius in **< 20 seconds**.
- **Safety:** Verified 5-minute software auto-cutoff to prevent motor overheating.
- **Logic:** Fan triggers 15 seconds after target time to allow for a "grace period."

User Interface Subsystem - Design Requirements & Verification



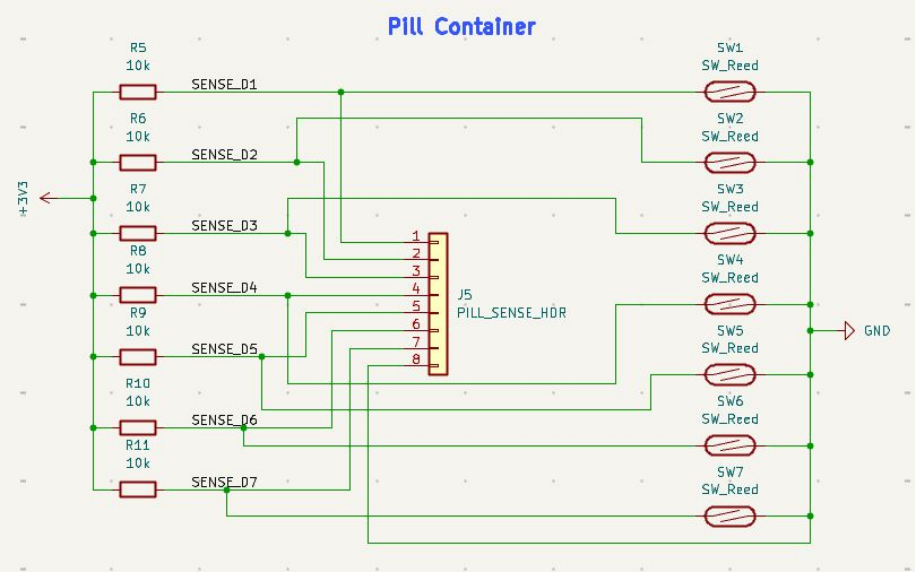
Design: * 128x64 SSD1306 OLED display.

- 3-Button navigation (UP, DOWN, SET) with external 10k pull-up resistors.

Verification Results:

- **Master Sync:** Day 1 time presets successfully propagate to Days 2 & 3 (66% faster setup).
- **Debounce:** 150ms software filter verified to eliminate mechanical button noise/double-clicks.
- **Demo Mode:** Manual pad-reset toggle verified via 2-second long-press on Pin 40.

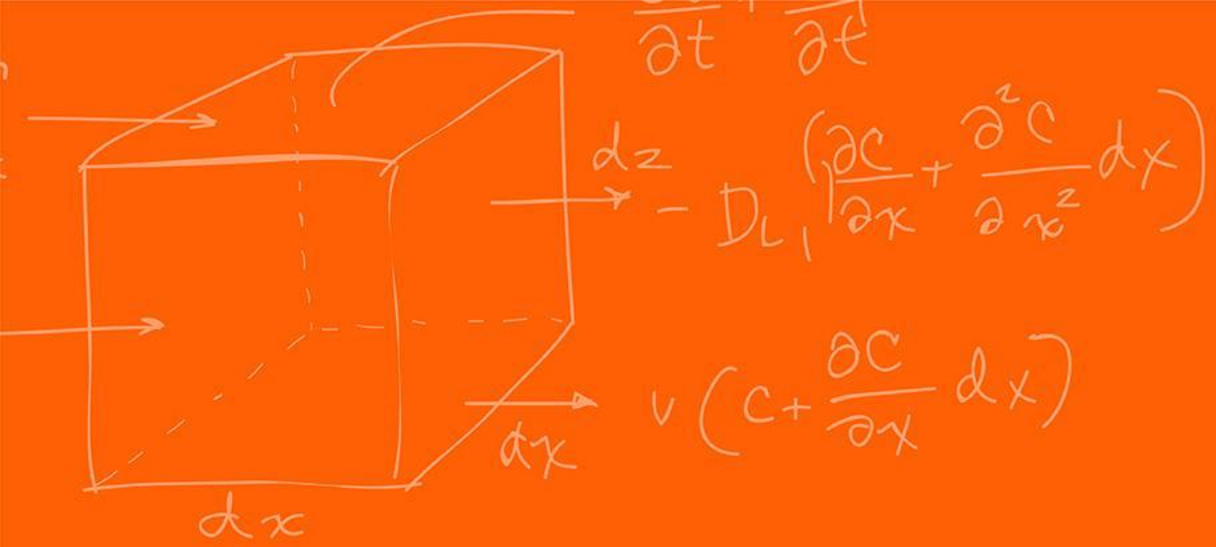
Pill Container Subsystem - Design Requirements & Verification

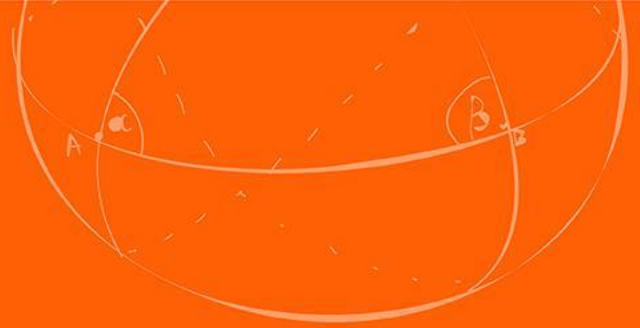


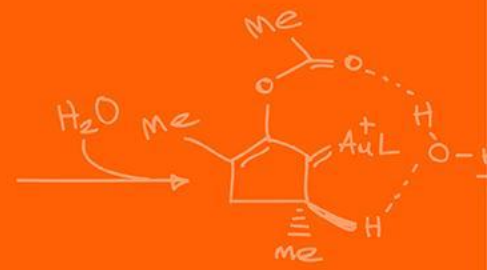
Design: Modified commercial pill box with hand-drilled holes; reed switches secured internally with hot glue.

Verification Highlights:

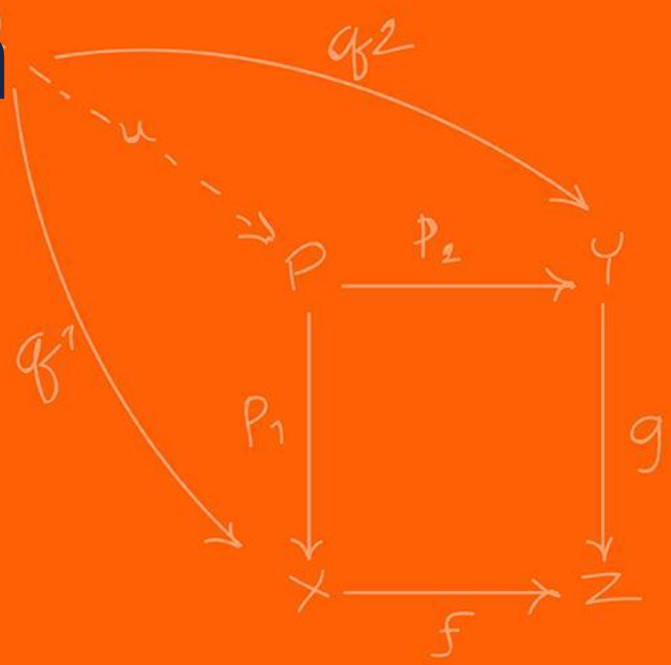
- **Signal Stability:** Verified logic LOW <0.8V and HIGH >2.4V using a multimeter.
- **Reliability:** Successfully completed over 100 open/close cycles per compartment without missed detections.
- **Debounce:** Verified no false transitions occur during lid toggling.



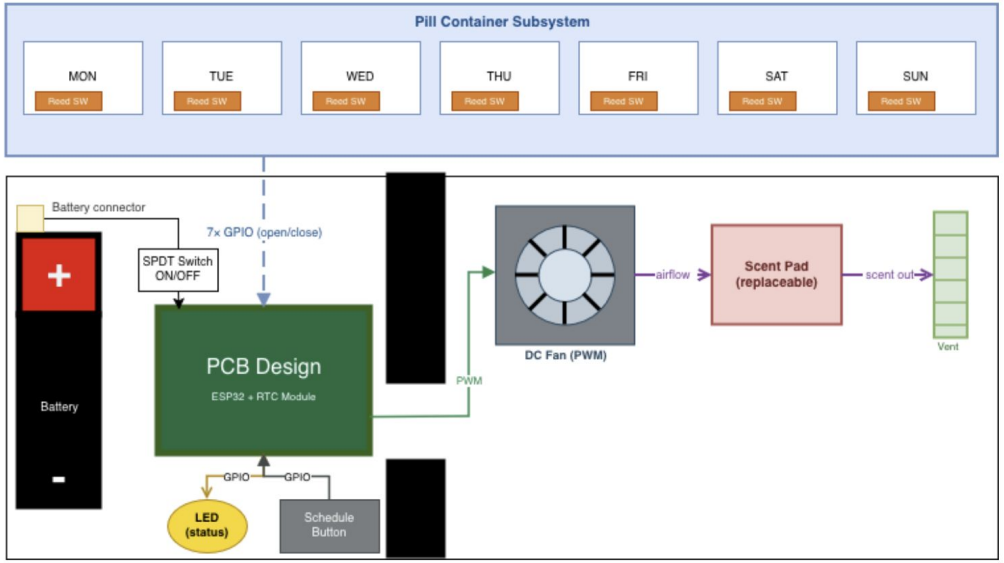




Mechanical Design

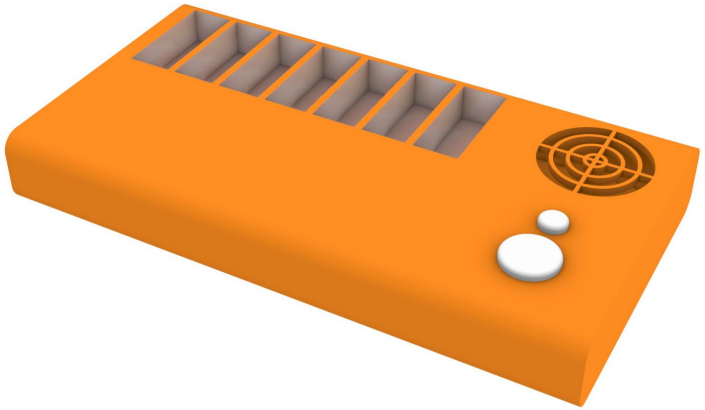


Pill Container Design - Design Requirements



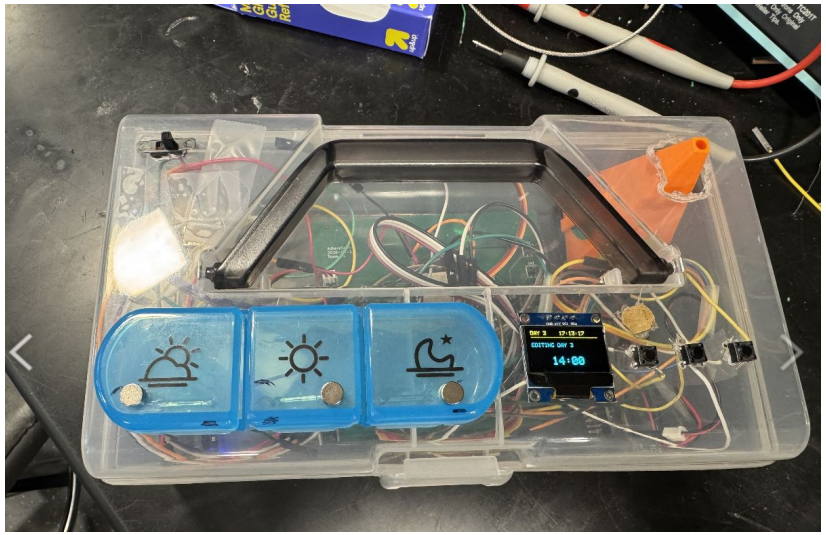
- Hold the pill compartments and open/close sensing hardware
- Reserve internal volume for PCB, ESP32, RTC, battery, fan, and wiring
- Separate medication storage from the scent-emission pathway
- Keep the prototype compact enough for a live demo and portable use

Pill Container Design - Initial 3D-Printed Prototype



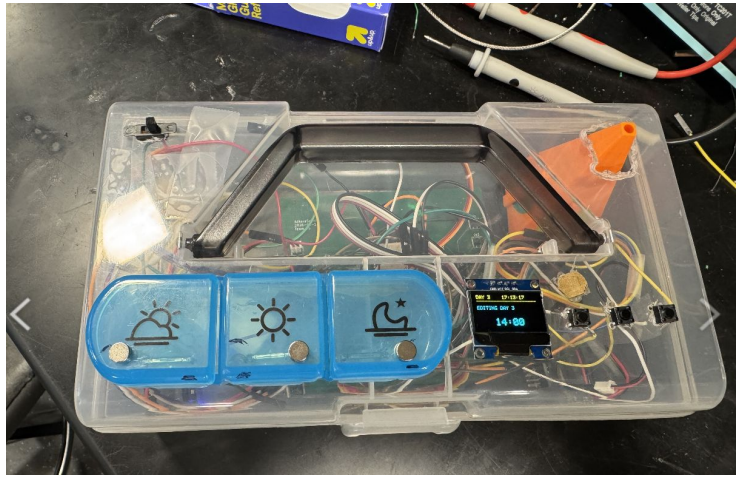
- Designed initial custom enclosure with 7 pill compartments and scent vent
- Design balanced portability, internal electronics volume, and printability
- Integration issue: final PCB, wiring, and fan required more internal volume than expected
- Design decision: switch to a commercial container for final integration reliability

Pill Container Design - Final Integrated Enclosure



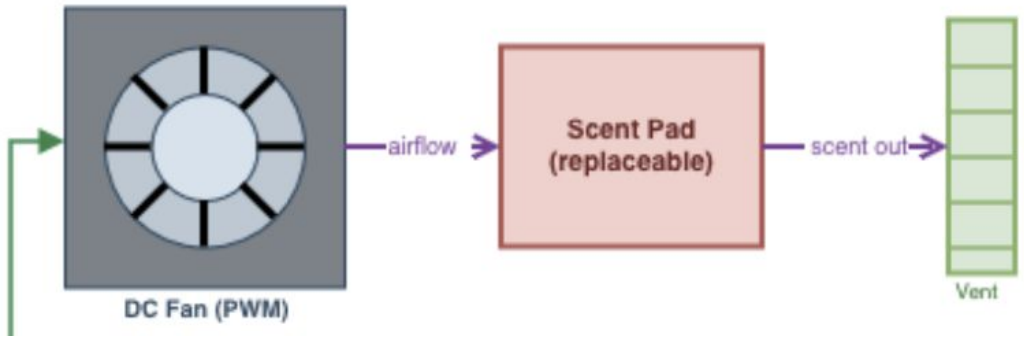
- Selected commercial container to provide sufficient internal volume
- Drilled/cut openings for wiring, airflow, and user-accessible components
- Mounted a 3-day pill organizer
- Allowed PCB, battery, fan, RTC, and wiring to fit in one self-contained box

Pill Container Design - Design Verification



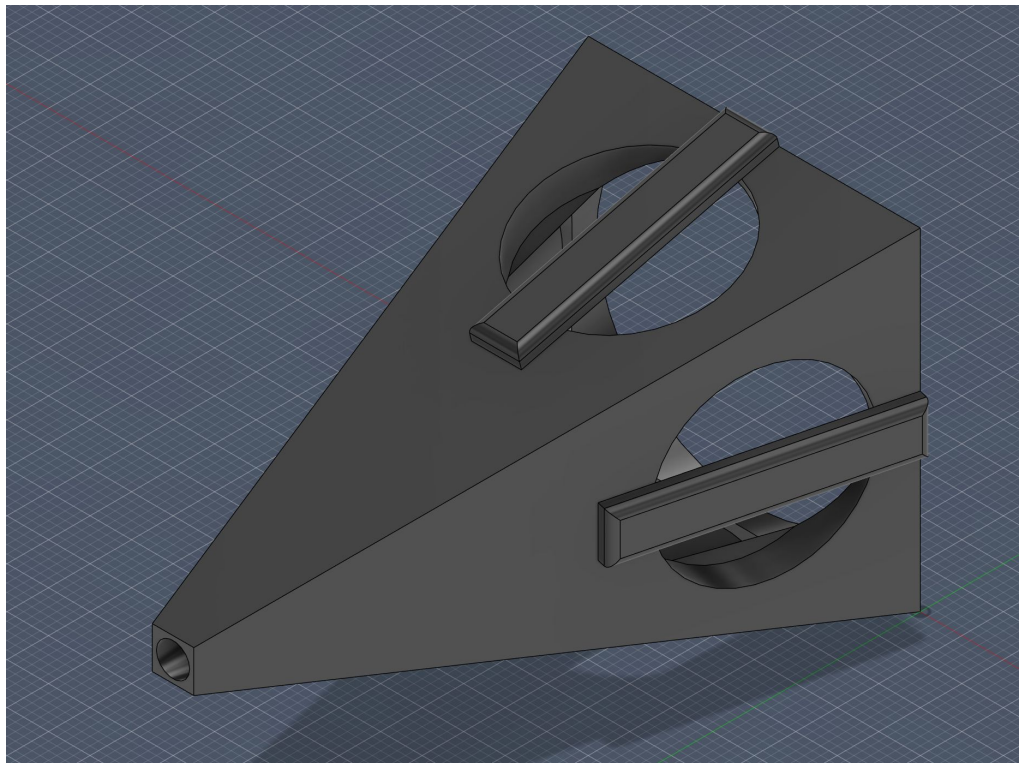
Requirement	Verification Method	Result
Hold the pill compartments and open/close sensing hardware	Visual + physical inspection	Pass
Reserve internal volume for PCB, ESP32, RTC, battery, fan, and wiring	Module placement check	Pass
Route airflow to the scent pad while separating scent from medication storage	Visual + airflow path check	Pass
Keep the prototype compact enough for a live demo and portable use	Visual + physical inspection	Pass
UI openings accessible	Button/display fit check	Pass

Scent Emitter Design - Design Requirements



- Fan must drive airflow across replaceable scent pad
- Scent should be detectable when fan is active
- Scent pad should be replaceable without tools
- Scent path should reduce passive leakage when inactive

Scent Emitter Design - Funnel Implementation



- Designed funnel geometry in Fusion 360 and 3D printed final part
- Funnel concentrates airflow and directs scent outward
- Funnel design with compacted container reduces passive scent leakage.
- Four scent-pad slots increase contact area between airflow and scent source
- 5 V fan positioned below funnel inlet to maximize airflow through the pad region

Scent Emitter Design - Design Verification

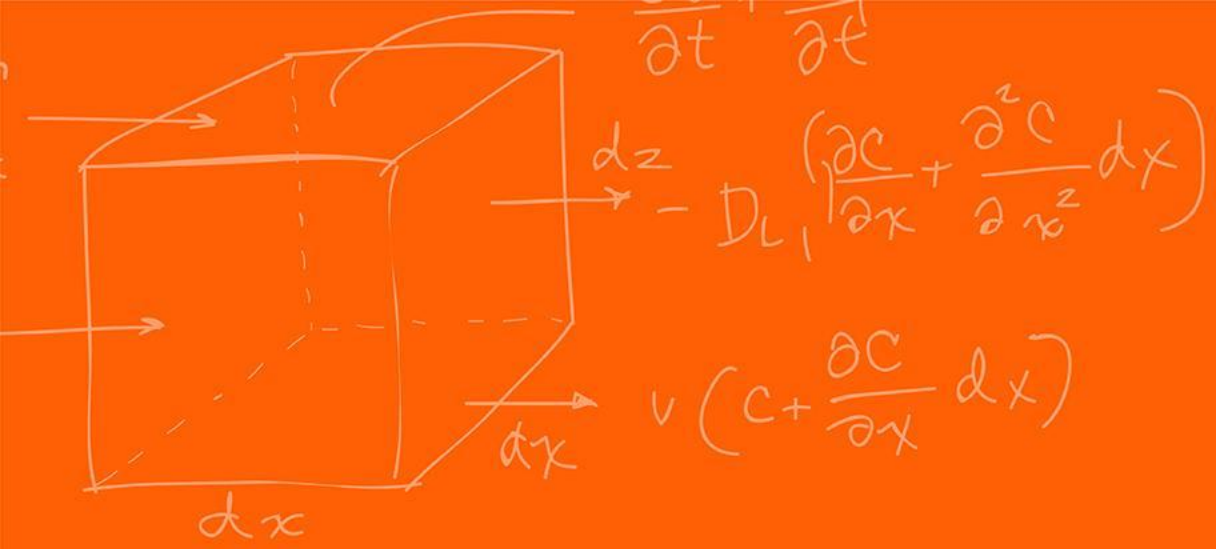
Requirement	Verification Method	Result
Fan must drive airflow across replaceable scent pad	Fan-on airflow check through funnel	Pass
Scent should be detectable when fan is active	Testers check at 50 cm	Pass
Scent pad should be replaceable without tools	Manual replacement test	Pass
Scent path should reduce passive leakage when inactive	Fan-off smell check	Partial Pass

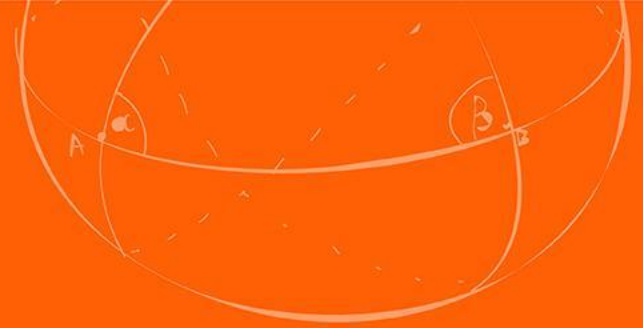
Conclusions & Future Work

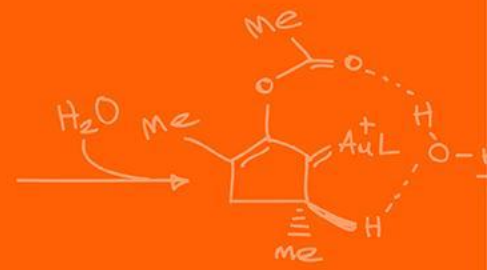
Conclusions & Future Work

- Built and verified a standalone scent-based medication reminder prototype that satisfies the pitched project requirements.
- Final design achieved the core demo goal: detecting a missed medication event and activating a scent-based reminder.
- Redesign priority: Adding a programming header on our PCB, sealed scent cartridge to improve passive-leakage control.
- Future work: conduct longer battery-life and scent-pad lifetime testing, improve scent intensity, and add an app interface for easier schedule setup and medication tracking.

Thank You







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