

# HOUSEHOLD SMART SCHEDULER

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## Abstract

The abstract is short (150 words or less) and provides enough of a summary of the report for the reader to decide whether to read the entire document. State very concisely what your device or system does, and the main findings and results of your project. Save background information (e.g., motivation, competitors) for the introduction and design details for the body of the report. Do not give an advertising pitch. Note that the abstract does not appear in the table of contents. (This achieved by stripping out the heading style.)

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When you double-clicked “ECE 445 Template.dotx,” you opened a new, untitled document in Microsoft Word, which has the main components of your final report set up for you. Save the new document, replace the red text and bracketed section heads with your own, insert carefully prepared graphics, follow the guidelines document (“Preparing Your Final Report for ECE 445”), proofread and revise, and you’ll likely end up with a successful report.

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# 1. Introduction

## 1.1 Problem

People, especially college students, often have a calendar or planner system to keep track of their events and tasks. What they tend to struggle with, however, is leaving home on time to their various plans. While digital calendars can provide reminders about upcoming events, they focus specifically on event starting times rather than external factors such as time spent getting ready, available modes of transportation, belongings such as keys. In a household with several members following different chaotic schedules, keeping track of all of these responsibilities can become extremely difficult.

Our Household Smart Scheduler addresses this issue by implementing a shared physical board that syncs personalized calendar information, departure countdowns, and key storage in one location. Rather than checking different apps and calendars individually, users can instead view their next upcoming event and how much time remains before their required departure all in one place, regardless of their intended mode of transportation. Attached to the device will be a key-sensing system, which indicates whether a user's keys are still present on their designated hook and provides a push-notification to their phone when keys are left behind.

Improving one's time management skills can decrease stress, contribute to safety, and promote one's general welfare. Leaving late can encourage individuals to rush, which can be especially dangerous while driving. Additionally, forgetting keys can create inconvenience, stress, and further delay. This system also considers social and cultural factors because it focuses on people with different work, school, and personal schedules individually. Economic consequences such as missed appointments, transportation splurges, and late arrivals are also reduced to avoid any unnecessary costs for individuals.

Environmentally, this board allows members to plan appropriately if they would like to walk to specific locations and helps users avoid unnecessary trips back and forth caused by missing belongings. By combining calendar data, bus schedules, traffic, and other online data with a simple physical reminder board, our project makes everyday departures more organized, convenient, and predictable.

## 1.2 Solution

The Household Smart Scheduler will be a wall-mounted electronic display that provides personalized departure information for at least three household members. The main visual interface will consist of two adjacent 64x64 RGB LED matrix panels. Each user's section will display the amount of time remaining before they need to leave by walking, driving, or taking a bus. Each user will be represented by a distinct assigned color, while yellow and red will be reserved for departure warnings. The system will retrieve upcoming events over Wi-Fi and calculate when each user should leave using

$$T_{\text{departure}} = T_{\text{event}} - T_{\text{travel}} - T_{\text{buffer}}$$

When a departure time is approaching, the corresponding countdown will change to yellow, and when the departure time is reached, it will change to red. An audible alert will also activate when departure time is reached.

Each user will have a designated key hook with a switch that detects whether their keys are still hanging on the board. If a user's departure time is approaching and the keys remain on

the hook, the system will provide a visual warning and send a notification to that user's phone. A Wi-Fi capable microcontroller on a custom PCB will coordinate calendar synchronization, departure-time calculations, key sensing, display control, phone notifications, and the buzzer. The PCB will also contain power regulation, sensor interfaces, display connections, and supporting driver circuitry.

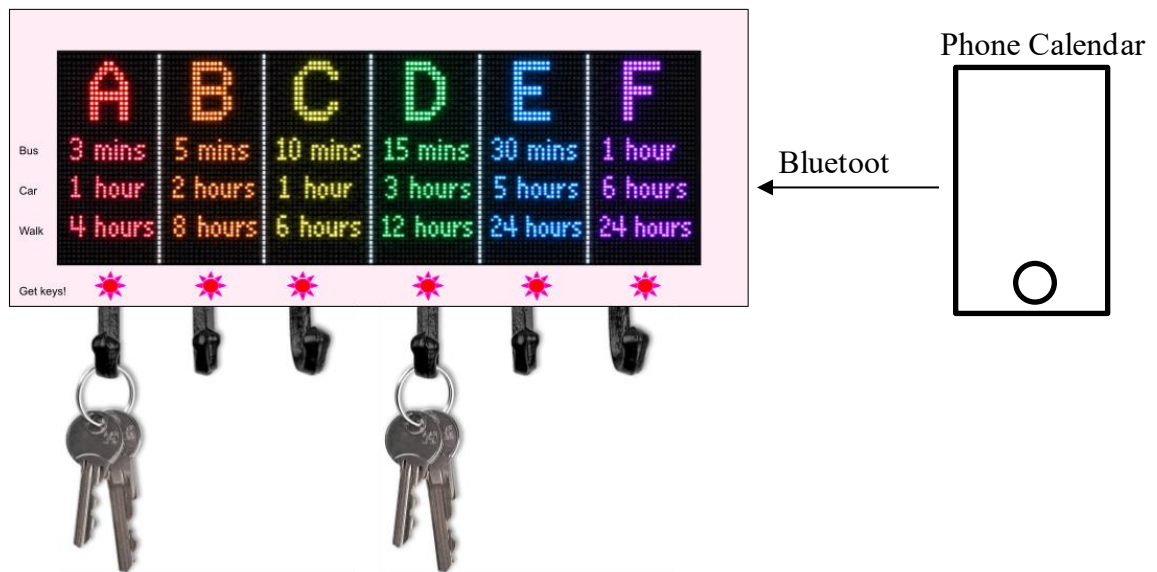


Figure 1

### 1.3 High-Level Requirements

- The system should support at least three users and display a departure countdown for bus, car, and walking for each user, with the displayed countdowns updating at least once every 60 seconds.
- The system should calculate each user's departure time with an error of no more than 1 minute, and activate the visual and audible leave-now alerts within 10 seconds of the calculated departure time.
- The key-sensing system should correctly detect whether a user's keys are present or removed in at least 90 out of 100 controlled tests, and when a user's departure time is approaching while their keys remain on the hook, the system should initiate a phone notification within 30 seconds.

## 2 Design

### 2.1 Block Diagram

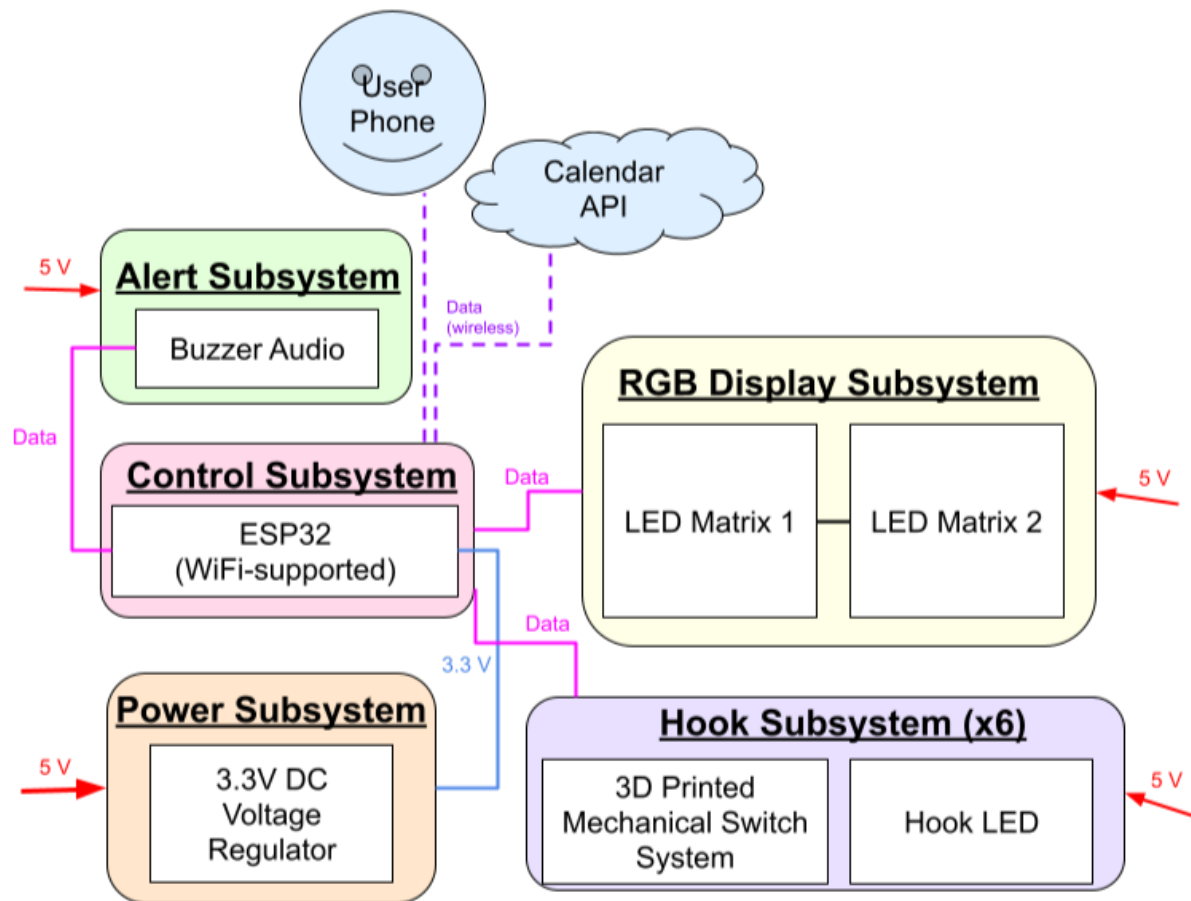


Figure 2

#### 2.1.1 Power Subsystem

The Power Subsystem supplies power to the two RGB LED matrix panels and the custom control PCB. The system will use an external regulated 5V DC power supply so that household AC mains voltage does not need to enter the custom PCB. The 5V supply will be distributed to each RGB matrix and to the custom PCB through separate power branches.

This subsystem supports all of the high-level requirements by providing stable power to the display, microcontroller, sensors, and alert circuitry necessary for the system to operate reliably.

Requirements:

- The power subsystem should accept a 5 V DC input
- The external power supply should provide at least 10 A at 5 V to support both RGB matrix panels and the control electronics
- The subsystem should provide a regulated 3.3 V supply for the microcontroller and sensor circuitry

- The two RGB matrix panels and control PCB should share a common ground

Tolerance Analysis: The Power Subsystem should supply an adequate 5V and 3.3V to each part, respectively, even when multiple loads require that voltage. A dependable voltage regulator will ensure that this is feasible.

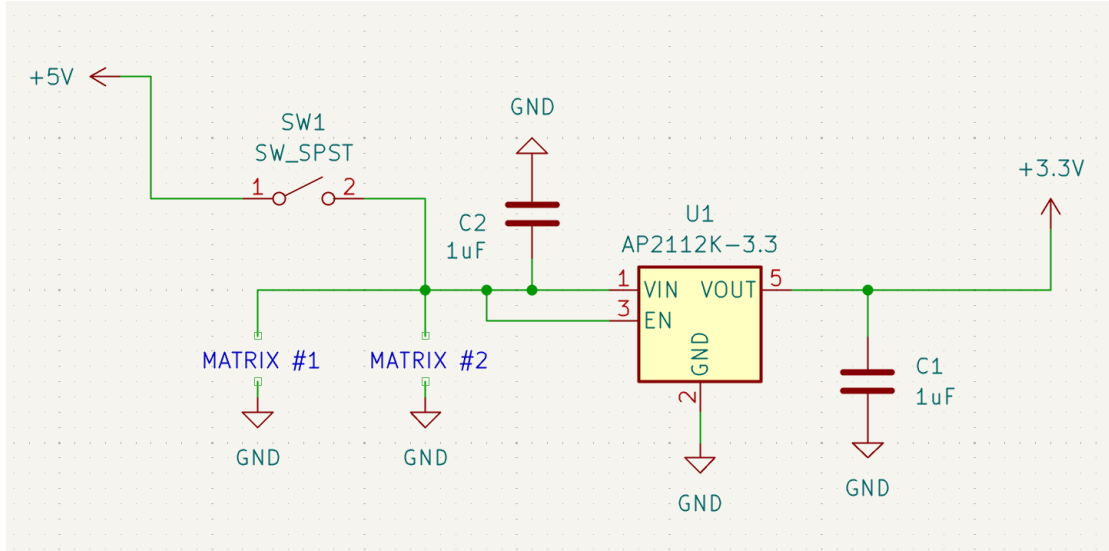


Figure 3

### 2.1.2 Central Control Subsystem

The Scheduling Subsystem will contain the system's Wi-Fi capable microcontroller. An ESP32 microcontroller supports 2.4 GHz Wi-Fi, operates from a nominal 3.3 V supply, and provides the digital interfaces required for communication with the displays and sensors. The microcontroller will retrieve each user's next calendar event, maintain the current time, calculate departure times, monitor key sensors, update the display, and activate alerts.

For each user, a separate departure time will be calculated for each supported transportation method as

$$T_{\text{departure}} = T_{\text{event}} - T_{\text{travel}} - T_{\text{buffer}}$$

where  $T_{\text{travel}}$  corresponds to the estimated travel time for walking, driving, or taking a bus. The remaining time before departure will then be calculated as

$$T_{\text{remaining}} = T_{\text{departure}} - T_{\text{current}}$$

The calculated remaining times for each transportation method will be sent to the RGB Display Subsystem. Each user will normally be displayed using their assigned color. However, yellow and red will be reserved for alert conditions and will not be available as user colors. A countdown will change to yellow when departure is approaching and red when the calculated departure time is reached.

Calendar information will be obtained through a digital calendar API. This design will use the minimum calendar permissions required to obtain upcoming events. For example, the Google Calendar API provides a scope that allows applications to view events without modifying them, and Google recommends selecting the narrowest authorization scope necessary.

This subsystem directly supports the high-level scheduling requirement by retrieving event information, calculating each user's departure time, and determining when visual, audible, and phone alerts should be activated.

Requirements:

- The controller should maintain scheduling information for at least three users
- The system shall retrieve each user's next calendar event through Wi-Fi

- Calendar information should be checked for updates at least once every 5 minutes while an Internet connection is available
- Departure time shall be calculated using  $T_{\text{departure}} = T_{\text{event}} - T_{\text{travel}} - T_{\text{buffer}}$  with an error of no more than 1 minute
- The leave-now state shall activate within 10 seconds of the calculated departure time
- The controller should read the key status for each of the three users and use this information when determining whether a key reminder is necessary

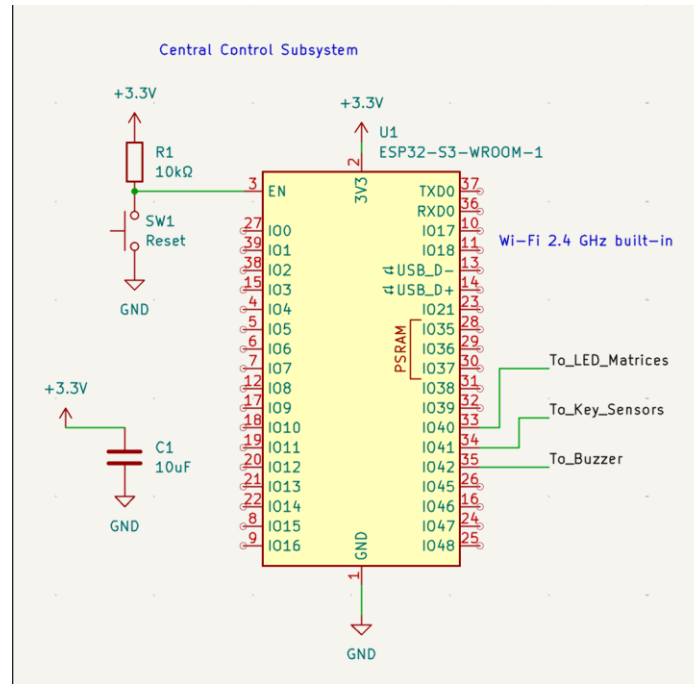


Figure 4

Tolerance Analysis: The Control Subsystem's greatest challenge is likely the speed at which it can deliver accurate time information. Ensuring that displayed departure times match calculated departure times down to a 10 second window will require the calculations and speed of execution to be optimized and monitored.

### 2.1.3 RGB Display Subsystem

The RGB Display Subsystem will use two Waveshare RGB Matrix 64x64 LED panels arranged side by side. Each panel contains 4096 RGB pixels with a resolution of 64x64 pixels, and uses the HUB75 interface. The two panels will form one larger display that is divided into separate columns, with one column assigned to each household member.

Each user's column will display their initial along with the amount of time remaining before they need to leave based on different transportation methods, such as walking, driving, or taking a bus. For example, if a user must leave in 10 minutes when walking but has 30 minutes before needing to leave by car, those values will be displayed in the corresponding rows. For each user's section, a distinct color will be used to make it easy to distinguish between household members. Red and yellow will be reserved exclusively for alert conditions and will not be available as user colors. The physical key hook associated with each user will be positioned underneath that user's display section.

The ESP32 will calculate the departure times and update the appropriate values on the RGB matrix. As a departure time approaches, the display can also visually emphasize the relevant value using

changes in color. This subsystem supports the scheduling requirement by providing each household member with a continuously visible indication of how long they have before they need to leave.

Requirements:

- The subsystem should use two 64 x 64 RGB LED matrix panels arranged side by side.
- The display should provide separate sections for at least three users
- Each user's section should display the amount of time remaining before departure for at least three transportation methods: bus, car, and walking
- Each user's section should be visually distinguishable from the other users using a different color or label
- The displayed departure times should update at least once every 60 seconds
- When a displayed departure time reaches zero, the system should provide a visible leave-now indication for that user

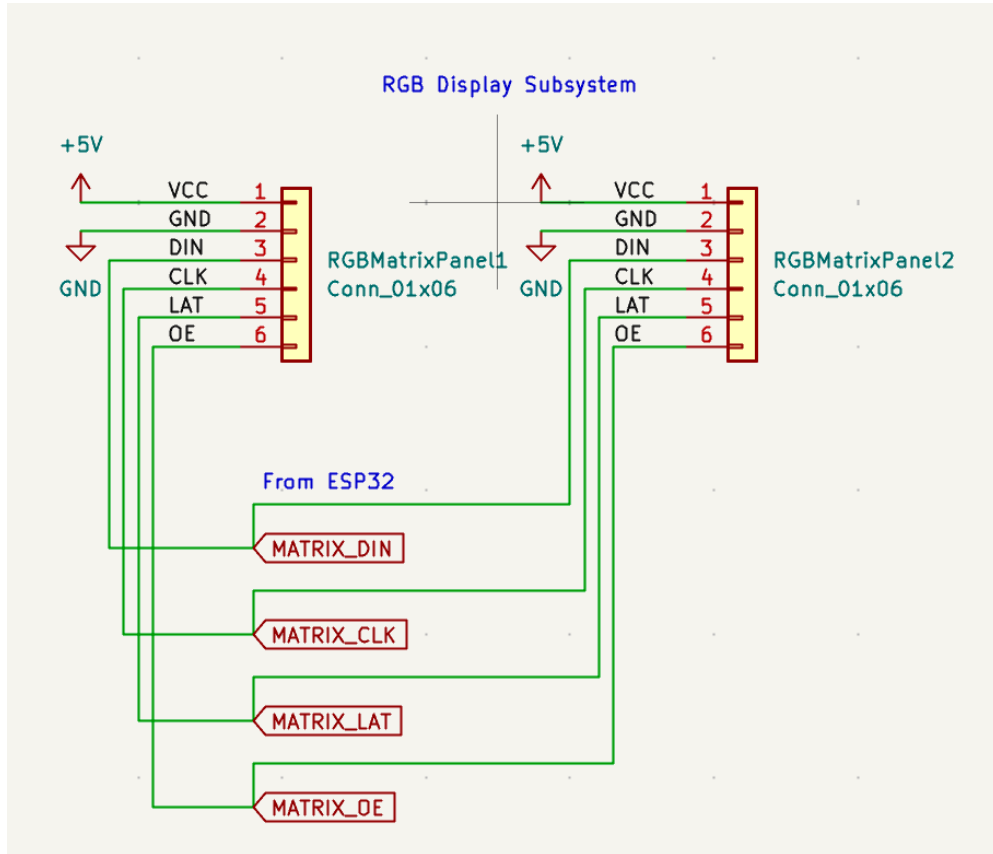


Figure 5

Tolerance Analysis: The RGB Display Subsystem must be able to fit all users within the provided number of pixels. This has been checked with a grid design that will allow information to be readable for up to 6 users. Additionally, the two panels must interface with one another in a seamless manner such that updating outputs do not produce glitches.

### 2.1.3 Hook Subsystem

The hook sensing subsystem is responsible for sending visual (LED) and wireless (phone notification) alerts to users who forget their keys on their hook. The design features six key hooks for users to store their keys when not in use.

To detect the presence of keys, the system uses the additional force produced by the weight of the keys. Each hook will be mounted to a 3D-printed sliding cage containing a spring and a normally-open

lever microswitch. The spring will be selected so that the weight of the hook alone is not sufficient to move the mechanism far enough to activate the switch. When keys are placed on the hook, their additional weight will cause the mechanism to move downward and close the switch. This closes the normally-open contact and completes the corresponding circuit branch, allowing the LED to illuminate. The switch state will also be monitored by the alert subsystem and used to determine whether a phone notification should be sent to the user when their keys have been forgotten.

Requirements:

- The subsystem should run off of a 5V DC input voltage.
- The spring constant  $K$  will be dependent on the mass of the selected hook, and calculated accordingly.
- An LED will be illuminated whenever keys are present on their respective hook.
- A user notification will be sent whenever keys have been left behind.

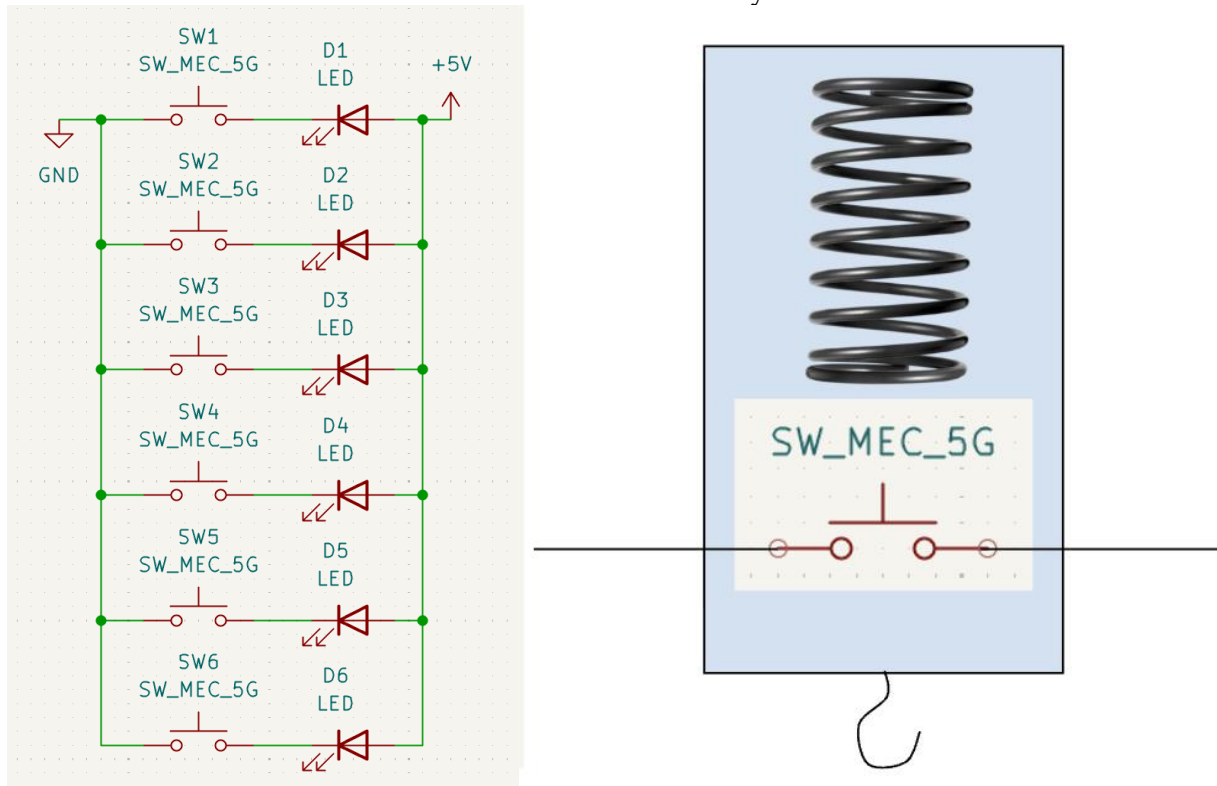


Figure 6

Tolerance Analysis: The Hook Subsystem must use physics to determine the correct dimensions of the 3D-printed block in addition to the correct spring constant and length. These measurements are backed up by science and will be verified using individual unit tests before being installed on the product. This will eliminate the trigger from going off when no keys are present, and ensure even the lightest set of keys will be detected accurately. Spring durability must also be taken into account for this subsystem to ensure product lifetime is substantial.

### 2.1.3 Alert Subsystem

Our Alert Subsystem will be responsible for notifying users of their calculated departure time and whether it is approaching or has already been reached. The ESP32 will determine the current alert state to display by leveraging the departure countdown calculated by the Scheduling Subsystem. Once a user has reached the “leave-now” state, the microcontroller will activate a buzzer to provide an audible notification. At this time, the RGB display will simultaneously provide a visual indication by providing

the corresponding user with directions to leave. This subsystem ensures that the users will receive a noticeable reminder without requiring them to actively check the board to know their status. The system enters the “leave-now” state when the countdown reaches zero minutes, and the alert should activate within 10 seconds of the calculated departure time.

Requirements:

- The visual and audible alerts will activate within 10 seconds of scheduled departure.
- The ESP32 will activate when a user enters the “leave-now” state and will communicate with the buzzer.
- The visual and audible alerts will correspond with the correct household member’s departure countdown.
- The alert subsystem will support at least three users’ data
- The audible alert will deactivate after a set amount of time to prevent continuous operation.

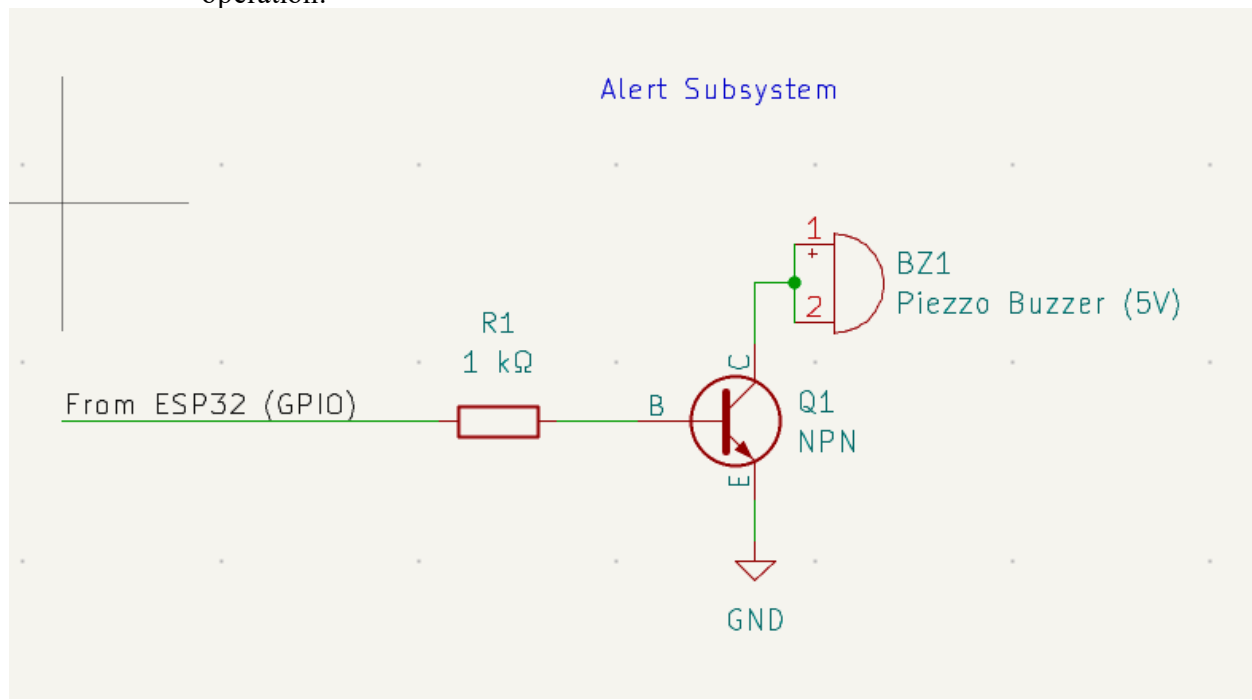


Figure 7

Tolerance Analysis: The Alert Subsystem must maintain accurate alerts for missing keys. The 10 second window for the lights and 30 second window for the phone push notifications must be maintained. This upholds the usefulness of the reminder- if alerts are triggered too late, the user will experience delays in their departure due to the latency.

### 3. Design Verification

Insert text.

#### 3.1 [Component or Block]

Insert text.

##### 3.1.1 [Subcomponent or subblock]

Insert text.



## 4. Costs

Make sure that any tables of costs are numbered, given titles, and cited directly in the text.

### 4.1 Parts

Following is a starter table for parts costs. Add cell contents as well as rows and, if necessary, columns. Update the table number according to your sequence. Note that columns 1 and 2 are set up for centered text (words) and columns 3-5 (numbers) are set up for right-alignment so that decimal points align.

**Table X   Parts Costs**

| <b>Part</b>  | <b>Manufacturer</b> | <b>Retail Cost<br/>(\$)</b> | <b>Bulk<br/>Purchase<br/>Cost (\$)</b> | <b>Actual Cost<br/>(\$)</b> |
|--------------|---------------------|-----------------------------|----------------------------------------|-----------------------------|
|              |                     |                             |                                        |                             |
|              |                     |                             |                                        |                             |
| <b>Total</b> |                     |                             |                                        |                             |

### 4.2 Labor

## 5. Conclusion

The conclusion may contain the following sections or others of your choosing.

### 5.1 Accomplishments

### 5.2 Uncertainties

### 5.3 Ethical considerations

One ethical limitation of our design is privacy. Since the device syncs with personal calendar information, it could reveal whether users are home. The ACM Code of Ethics emphasizes the importance of protecting user privacy and personal information, and our system will comply with these requirements by ensuring that it only accesses information necessary to display the next event and calculate departure time. Calendar information will not be stored longer than necessary, and users of the device must purposefully connect their calendars to the system.

The IEEE Code of Ethics upholds the standard of protecting public safety and honestly communicating the limitations of a product or service. In order to align with these ideals, we will heavily consider safety and reliability throughout our construction and testing process to avoid incorrect calendar synchronization, sensor readings, or departure calculations that could provide users with faulty information and directions. Throughout development, we will constantly test the calendar, key sensors, alerts, and departure calculations before our demonstration. Additionally, to comply with safety regulations and ECE 445 laboratory requirements, we will avoid electrical risks such as short circuits, overheating, and incorrect voltages by utilizing regulated low-voltage power supplies and properly rated components.

The intended societal and economic impact of our product is to assist households in organizing their schedules, remind them of important personal belongings, and reduce departure delays. We do recognize, however, that the key-sensing feature of our project could be misused to track when individuals are home, so no information from this feature will be stored permanently. Environmentally, we hope to limit the use of unnecessary electrical components and power consumption. Overall, throughout the entirety of our project, we aim to prioritize privacy, safety, reliability, and responsible use.

### 5.4 Future work

## References

- [1] *Motorola Semiconductor Data Manual*, Motorola Semiconductor Products, Inc., Phoenix, AZ, 2007.
- [2] *Double Data Rate (DDR) SDRAM*, datasheet, Micron Technology, Inc., 2000. Available at: <http://download.micron.com/pdf/datasheets/dram/ddr/512MBDDR4x8x16.pdf>
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- [6] G. Liu, "TDM and TWDM de Bruijn nets and shufflenets for optical communications," *IEEE Transactions on Computers*, vol. 59, no. 1, pp. 695-701, June 2011.
- [7] S. Al Kuran, "The prospects for GaAs MESFET technology in dc-ac voltage conversion," in *Proceedings of the Fourteenth Annual Portable Design Conference*, 2010, pp. 137-142.
- [8] K. E. Elliott and C. M. Greene, "A local adaptive protocol," Argonne National Laboratory, Argonne, IL, Tech. Rep. 916-1010-BB, 2006.
- [9] J. Groeppelhaus, "Java 5.7 tutorial: Design of a full adder," class notes for ECE 290, Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, 2011.

## Appendix A Requirement and Verification Table

An appendix is a good place for the Requirement and Verification Table from your design review. Below is a starter table. Including these details here will help to avoid lengthy and tedious narrative descriptions in the main text, which may not be of immediate interest to your imagined audience of company managers and professionals. Any requirement that is not verified should be explained either in the main text or the appendix. Note that both the pagination and the numbering of figures, tables, and equations continues from main text to appendices.

**Table X System Requirements and Verifications**

| Requirement                                                                   | Verification                                                                      | Verification status<br>(Y or N) |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------|
| 1. Requirement<br>a. Subrequirement<br>b. Subrequirement<br>c. Subrequirement | 1. Verification<br>a. Subverification<br>b. Subverification<br>c. Subverification |                                 |
| 2. Requirement<br>a. Subrequirement<br>b. Subrequirement<br>c. Subrequirement | 2. Verification<br>a. Subverification<br>b. Subverification<br>c. Subverification |                                 |
| 3.                                                                            | 3.                                                                                |                                 |
| 4.                                                                            | 4.                                                                                |                                 |