

# Aviator Design Document

David Thoe, Joshua Kim, Zeke Ulrich, Juan Vargas

September 18, 2025

GTA: Zixiao Ma  
Professor: Ryan Beasley



Figure 0.0.1: [Caption]

# Contents

<b>1</b>	<b>Introduction</b>	<b>9</b>
1.1	Executive Description . . . . .	9
1.2	User Stories . . . . .	9
<b>2</b>	<b>Design Requirements</b>	<b>10</b>
2.1	Requirements . . . . .	10
2.2	Factors Influencing Requirements . . . . .	11
2.2.1	Public Health, Safety, and Welfare . . . . .	11
2.2.2	Cultural Factors . . . . .	11
2.2.3	Social Factors . . . . .	11
2.2.4	Environmental Factors . . . . .	11
2.2.5	Economic Factors . . . . .	11
<b>3</b>	<b>System Overview</b>	<b>12</b>
3.1	System Block Diagram . . . . .	12
3.2	System Activity Diagram . . . . .	13
3.3	System Mechanical Design (Extra Credit) . . . . .	15
3.4	Integration Approach . . . . .	17
3.5	System Photographs . . . . .	18
<b>4</b>	<b>Subsystems</b>	<b>20</b>
4.1	Subsystem 1: Processing . . . . .	21
4.1.1	Subsystem Diagrams . . . . .	21
4.1.2	Specifications . . . . .	21
4.1.3	Subsystem Interactions . . . . .	22
4.1.4	Core ECE Design Tasks . . . . .	22
4.1.5	Schematics . . . . .	22
4.1.6	Parts . . . . .	22
4.1.7	Algorithm . . . . .	22
4.1.8	Theory of Operation . . . . .	23
4.1.9	Specifications Measurement . . . . .	23
4.1.10	Standards . . . . .	23
4.2	Subsystem 2: [Subsystem Name] . . . . .	25
4.2.1	Subsystem Diagrams . . . . .	25
4.2.2	Specifications . . . . .	25
4.2.3	Subsystem Interactions . . . . .	25
4.2.4	Core ECE Design Tasks . . . . .	25
4.2.5	Schematics . . . . .	25
4.2.6	Parts . . . . .	25

4.2.7	Algorithm . . . . .	25
4.2.8	Theory of Operation . . . . .	25
4.2.9	Specifications Measurement . . . . .	25
4.2.10	Standards . . . . .	26
4.3	Subsystem 3: [Subsystem Name] . . . . .	29
4.3.1	Subsystem Diagrams . . . . .	29
4.3.2	Specifications . . . . .	29
4.3.3	Subsystem Interactions . . . . .	29
4.3.4	Core ECE Design Tasks . . . . .	29
4.3.5	Schematics . . . . .	29
4.3.6	Parts . . . . .	29
4.3.7	Algorithm . . . . .	29
4.3.8	Theory of Operation . . . . .	29
4.3.9	Specifications Measurement . . . . .	29
4.3.10	Standards . . . . .	30
4.4	Subsystem 4: [Subsystem Name] . . . . .	33
4.4.1	Subsystem Diagrams . . . . .	33
4.4.2	Specifications . . . . .	33
4.4.3	Subsystem Interactions . . . . .	33
4.4.4	Core ECE Design Tasks . . . . .	33
4.4.5	Schematics . . . . .	33
4.4.6	Parts . . . . .	33
4.4.7	Algorithm . . . . .	33
4.4.8	Theory of Operation . . . . .	33
4.4.9	Specifications Measurement . . . . .	33
4.4.10	Standards . . . . .	34
<b>5</b>	<b>PCB Design</b>	<b>37</b>
5.1	PCB Schematics . . . . .	37
5.2	PCB Layout . . . . .	38
<b>6</b>	<b>Final Status of Requirements</b>	<b>40</b>
<b>7</b>	<b>Team Structure</b>	<b>41</b>
7.1	Team Member 1 . . . . .	41
7.2	Team Member 2 . . . . .	41
7.3	Team Member 3 . . . . .	42
7.4	Team Member 4 . . . . .	42
<b>8</b>	<b>Bibliography</b>	<b>43</b>
<b>9</b>	<b>Appendices</b>	<b>44</b>

## List of Figures

0.0.1 [Caption] . . . . .	2
3.1.1 System Block Diagram . . . . .	12
3.2.1 System Activity Diagram . . . . .	14
3.3.1 System Mechanical Design . . . . .	16
3.5.1 [Photo Name] . . . . .	19
4.1.1 Subsystem Block Diagram . . . . .	21
4.1.2 [Schematic Name] . . . . .	24
4.2.1 Subsystem Block Diagram . . . . .	27
4.2.2 [Schematic Name] . . . . .	28
4.3.1 Subsystem Block Diagram . . . . .	31
4.3.2 [Schematic Name] . . . . .	32
4.4.1 Subsystem Block Diagram . . . . .	35
4.4.2 [Schematic Name] . . . . .	36
5.1.1 PCB Schematic . . . . .	37
5.2.1 PCB Layout . . . . .	39

**List of Tables**

1    Revision Log . . . . . 7

## Revision Log

Date	Revision	Changes
5/3/2024	v0.1	Initial Release
9/18/2025	v1.0	First Draft

Table 1: Revision Log

## Glossary

- **3D audio technology** Simulation that creates the illusion of sound sources placed anywhere in 3 dimensional space, including behind, above or below the listener.
- **API** Application Programming Interface.



# 1 Introduction

## 1.1 Executive Description

Retro nearby flight information display.

## 1.2 User Stories

User Story 1 – The Long-Time Aviation Hobbyist As a long-time aviation hobbyist who has spent years tracking flights through phone apps, I’m tired of paying for subscriptions just to unlock basic features. I want a device that gives me real-time flight information without hidden costs, while also providing a tactile, nostalgic experience that reminds me of classic aviation boards. By having the Aviator on my desk, I can finally stay connected to the aviation world without feeling like I’m paying a premium for something that should be standard and accessible.

User Story 2 – The Casual Aviation Enthusiast As someone with a general interest in aviation, I don’t need a full cockpit-level tracker, but I do want something that feels engaging and easy to use. Standard apps are flat, cluttered, and frankly too much for a novice like myself, but the Aviator project makes flight tracking simple, physical, and fun. I can glance at the board, see arrivals and departures, and feel connected to the aviation scene effortlessly. The setup process was simply plug and play. Additionally, I don’t have to pay a dime for the product. For me, it’s about accessibility and enjoying aviation in a personal, low-effort, high-impact way.

User Story 3 – The Purdue ECE Student As a Purdue ECE student, I’m drawn to the Aviator not only as a hobby project that I can tinker with, but also as a nod to Purdue’s deep aviation legacy. It’s inspiring to own a piece of tech that bridges my academic interests in circuits and embedded systems with Purdue’s reputation in aerospace. I want a tracker that feels hands-on, customizable, and personal—something that makes me feel part of both my field of study and Purdue’s aviation history every time I glance at it. Given the nature of the project and its ability to be completed by an individual excites me, as it gives me the stepping stone I needed to start tracking flights.

## 2 Design Requirements

### 2.1 Requirements

1. The device must display accurate information.
2. The display must not interfere with user's well-being by, for example, displaying at excessive luminosity, updating rapidly in a distracting manner, or being excessively bulky.
3. The device must not infringe on any person's reasonable expectation of privacy.
4. The device must be language-agnostic wherever possible.
5. The device must be responsive and intuitive.
6. The device must have robust error handling and recovery.
7. The physical device should be easily replicated with widely available parts.
8. The code for the device must be open-source and well-documented.
9. The device should be as durable and environmentally friendly as possible so as not to contribute to e-waste.
10. The device must not contribute to noise or visual pollution of any space.
11. The device must be energy-efficient.
12. The device must minimize construction and recurring costs.
13. The device must not infringe on right to repair.
14. The device must mount and dismount without damage to vertical surfaces.

## **2.2 Factors Influencing Requirements**

### **2.2.1 Public Health, Safety, and Welfare**

1. User well-being
2. Privacy

### **2.2.2 Cultural Factors**

1. Language differences
2. Ease of use

### **2.2.3 Social Factors**

1. Ease of replication
2. Open-source and documentation

### **2.2.4 Environmental Factors**

1. Environmental friendliness and e-waste
2. Noise and visual pollution
3. Energy efficiency

### **2.2.5 Economic Factors**

1. Cost
2. Repairability

### 3 System Overview

#### 3.1 System Block Diagram

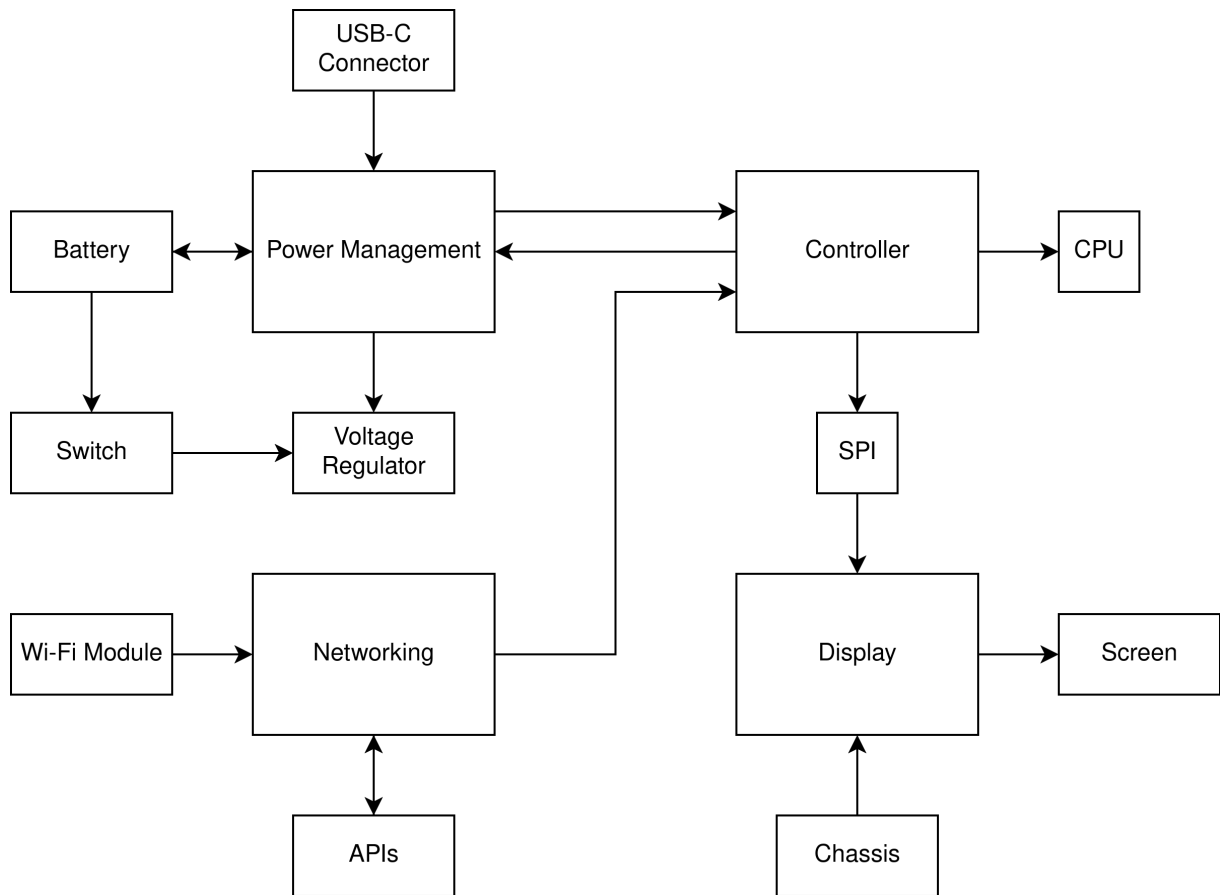


Figure 3.1.1: System Block Diagram

## 3.2 System Activity Diagram

[DD1+]



Figure 3.2.1: System Activity Diagram

### 3.3 System Mechanical Design (Extra Credit)

[DD3+]



Figure 3.3.1: System Mechanical Design



### 3.4 Integration Approach

[**DD3+**] [Theory behind the system design, with reference to subsystem integration within your system – i.e., explain how it is supposed to work, but not whether it did actually work]  
[Type here]

### 3.5 System Photographs

[**DD3+**] [Photograph of assembled system, intended to highlight user interaction / controls. If system is split into multiple parts, show a composite of more than one photograph with all key user interactions / controls. ]



Figure 3.5.1: [Photo Name]

## 4 Subsystems

## 4.1 Subsystem 1: Processing

### 4.1.1 Subsystem Diagrams

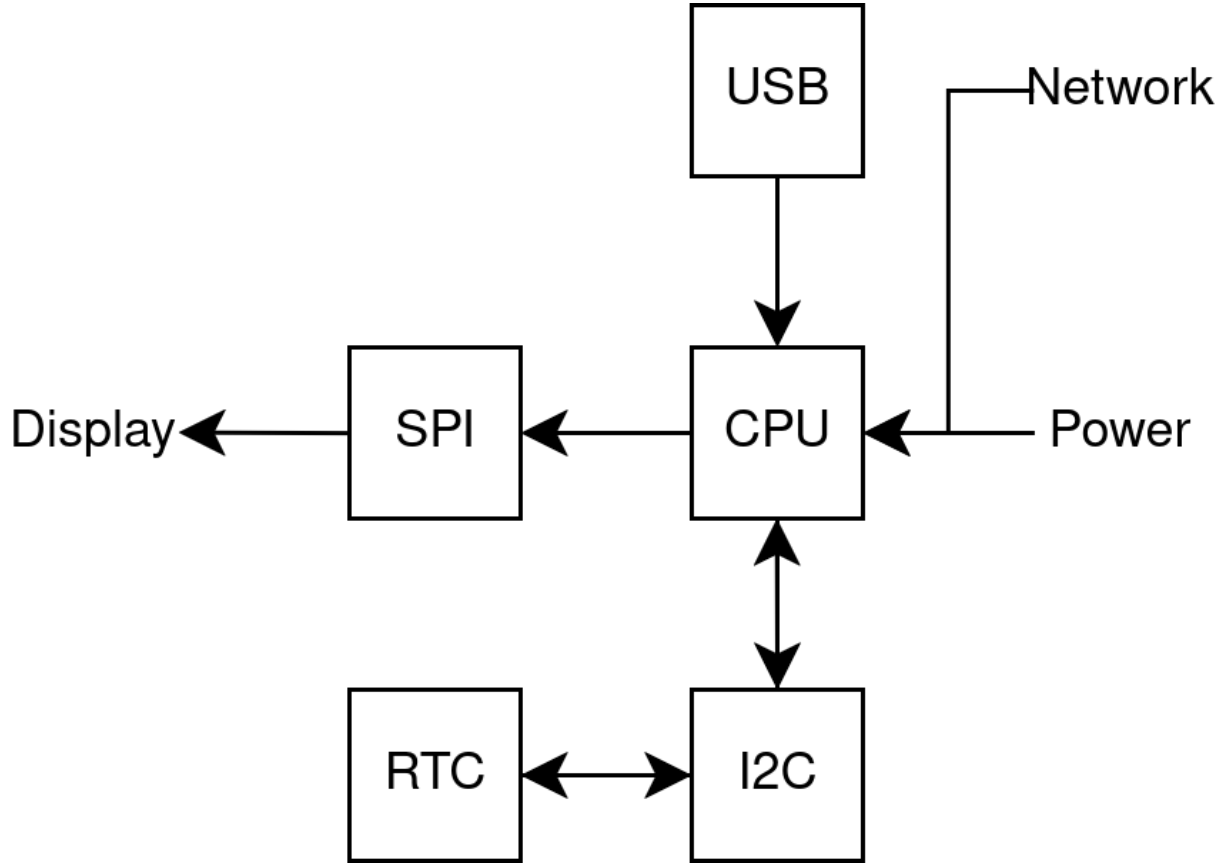


Figure 4.1.1: Subsystem Block Diagram

### 4.1.2 Specifications

1. Support SPI clock  $\geq 20$  MHz
2. Display update latency  $\leq 16$  ms
3. Support configurable API refresh interval between 60 and 300 s
4. API end-to-end fetch latency  $\leq 2$  s

### 4.1.3 Subsystem Interactions

The core computer interfaces with all other subsystems. The battery/power management unit supplies it with power. Running processes direct and receive information from the network module. It communicates with the digital dot matrix display via SPI according to display drivers on the controller.

### 4.1.4 Core ECE Design Tasks

- **ENGR 16100:** Teamwork & project documentation.
- **CS 15900:** Fundamentals of programming.
- **ECE 36200:** PCB design and embedded software development.

### 4.1.5 Schematics

[Type here **DD2+**]

### 4.1.6 Parts

- ESP32-S3
- DS3231
- PCB

### 4.1.7 Algorithm

```
initialize clock , network , display , location

always
    wifi keep alive
    error handling

every minute
    update display time

    make API call for flight data
    parse data

    if battery powered
        check battery voltage
        add battery to data
```

```
    add time, weather, flight info to data
    convert data to pixel buffer
    push pixel buffer to display

every hour
    sync RTC with network time

    make API call for weather
```

#### 4.1.8 Theory of Operation

[Type here **DD2+**]

#### 4.1.9 Specifications Measurement

[**DD3+** Every specification here should match the specification above. ]

1. [Copy specification here. ]  
[Explain the specification here. Add photoes if necessary. ]

#### 4.1.10 Standards

[**DD1+**]

- **IPC-2221**: Governs PCB trace width, spacing, creepage/clearance, via rules, grounding, etc.
- **IPC-A-610**: Covers soldering quality and workmanship.
- **RFC 5905**: Protocol for syncing ESP time to internet.



Figure 4.1.2: [Schematic Name]



## **4.2 Subsystem 2: [Subsystem Name]**

### **4.2.1 Subsystem Diagrams**

[DD1+]

### **4.2.2 Specifications**

1. [Type here DD1+]

### **4.2.3 Subsystem Interactions**

[Type here DD1+]

### **4.2.4 Core ECE Design Tasks**

[DD1+ Write tasks and course that helps accomplish that task]

- **ECE xxxxx:** [Type the relationship here. ]

### **4.2.5 Schematics**

[Type here DD2+]

### **4.2.6 Parts**

- [Type here DD1+]

### **4.2.7 Algorithm**

[Type here DD1+]

### **4.2.8 Theory of Operation**

[Type here DD2+]

### **4.2.9 Specifications Measurement**

[DD3+ Every specification here should match the specification above. ]

1. [Copy specification here. ]  
[Explain the specification here. Add photoes if necessary. ]

#### 4.2.10 Standards

[DD1+]

- [Standard Name]: [Describe the standards and explain the connection]



Figure 4.2.1: Subsystem Block Diagram



Figure 4.2.2: [Schematic Name]

### **4.3 Subsystem 3: [Subsystem Name]**

#### **4.3.1 Subsystem Diagrams**

[DD1+]

#### **4.3.2 Specifications**

1. [Type here DD1+]

#### **4.3.3 Subsystem Interactions**

[Type here DD1+]

#### **4.3.4 Core ECE Design Tasks**

[DD1+ Write tasks and course that helps accomplish that task]

- **ECE xxxxx:** [Type the relationship here. ]

#### **4.3.5 Schematics**

[Type here DD2+]

#### **4.3.6 Parts**

- [Type here DD1+]

#### **4.3.7 Algorithm**

[Type here DD1+]

#### **4.3.8 Theory of Operation**

[Type here DD2+]

#### **4.3.9 Specifications Measurement**

[DD3+ Every specification here should match the specification above. ]

1. [Copy specification here. ]  
[Explain the specification here. Add photoes if necessary. ]

#### 4.3.10 Standards

[DD1+]

- [Standard Name]: [Describe the standards and explain the connection]



Figure 4.3.1: Subsystem Block Diagram



Figure 4.3.2: [Schematic Name]



## **4.4 Subsystem 4: [Subsystem Name]**

### **4.4.1 Subsystem Diagrams**

[DD1+]

### **4.4.2 Specifications**

1. [Type here DD1+]

### **4.4.3 Subsystem Interactions**

[Type here DD1+]

### **4.4.4 Core ECE Design Tasks**

[DD1+ Write tasks and course that helps accomplish that task]

- **ECE xxxxx:** [Type the relationship here. ]

### **4.4.5 Schematics**

[Type here DD2+]

### **4.4.6 Parts**

- [Type here DD1+]

### **4.4.7 Algorithm**

[Type here DD1+]

### **4.4.8 Theory of Operation**

[Type here DD2+]

### **4.4.9 Specifications Measurement**

[DD3+ Every specification here should match the specification above. ]

1. [Copy specification here. ]  
[Explain the specification here. Add photoes if necessary. ]

#### 4.4.10 Standards

[DD1+]

- [Standard Name]: [Describe the standards and explain the connection]



Figure 4.4.1: Subsystem Block Diagram



Figure 4.4.2: [Schematic Name]

## 5 PCB Design

### 5.1 PCB Schematics

[DD3+]

4

Figure 5.1.1: PCB Schematic

## 5.2 PCB Layout

[DD3+]



Figure 5.2.1: PCB Layout

## 6 Final Status of Requirements

[**DD3+**] [If met, give a detailed explanation of the requirement. If partially met, mention what has been met and a reason for why the complete requirement couldn't be achieved. If not met, give an explanation for why the requirement couldn't be met in the product. Add as many requirements as you had in your earlier design documents here. ]

1. Requirement 1: [Copy your requirement above here]  
**Met:** [Explanation]
2. Requirement 2: [Copy your requirement above here]  
**Partially Met:** [Explanation]
3. Requirement 3: [Copy your requirement above here]  
**Not Met:** [Explanation]



## 7 Team Structure

[DD1+]

### 7.1 Team Member 1

[Name Here]

Major: [FILL IN]

Contact: [user]@purdue.edu

Team Role: [Technical and Professional Roles in the team]

Bio: [Short Introduction here]

### 7.2 Team Member 2

[Name Here]

Major: [FILL IN]

Contact: [user]@purdue.edu

Team Role: [Technical and Professional Roles in the team]

Bio: [Short Introduction here]

### 7.3 Team Member 3



**Zeke Ulrich**

Major: Computer Engineering

Contact: pulrich@purdue.edu

Team Role: Treasurer

Bio: Zeke is the processing and PCB design specialist. At Purdue, he belongs to the Marine Corp Officer Candidate Program, Eta Kappa Nu, Tau Beta Pi, and Purdue's Effective Altruism community. Outside Purdue, he is president of the nonprofit DuelGood and works for the government in cybersecurity. In the future he hopes to study international relations as a Truman scholar, start a family, and volunteer as a firefighter. He enjoys athletics and spending time with his friends.

### 7.4 Team Member 4

**[Name Here]**

Major: [FILL IN]

Contact: [user]@purdue.edu

Team Role: [Technical and Professional Roles in the team]

Bio: [Short Introduction here]

## 8 Bibliography

[Here are some examples. IEEE format can be found on [Purdue OWL](#). ]

### References

- [1] "Data Platform - Open Power System data," Apr. 15, 2020. [https://data.open-power-system-data.org/household\\_data/](https://data.open-power-system-data.org/household_data/)
- [2] Author, "Title," *Journal*, volume, number, page range, month year, DOI.
- [3] Author. "Page." Website. URL(accessed month day, year)

## 9 Appendices

[This section is mainly designed for code. You can directly generate a somewhat decent display of your code file or psuedo code by using the template provided below. You can have as many appendix as you want. In the document, you can refer to the code posted here instead of pasting the whole code in the body. ]