Product Requirements Document (PRD)

Product Name: Airman XB-70 Pro Flight Computer

Version: 1.3

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Author: Airman Development Team

1. Overview

The Airman XB-70 Pro is a cutting-edge flight computer tailored for comprehensive pre-flight planning, in-flight navigation, and post-flight data analysis (FDA). Designed to integrate seamlessly with the XB-30 GPS module, this device provides modular functionality with real-time performance, enhanced navigation, and accurate environmental data calibration. With FAA-compliant design principles (excluding wireless connectivity), the XB-70 Pro is a high-performance tool for aviation professionals, student pilots, and hobbyists.

The XB-70 Pro features a 2x3 matrix user interface (UI), customisable themes, and sensor calibration based on ISA standards for precise altitude and environmental data. Its robust yet intuitive design ensures it meets the demands of both training and professional aviation environments.

2. Goals and Objectives

Primary Objective

Deliver a modular, FAA-compliant flight computer that enhances the entire aviation workflow —spanning pre-flight, in-flight, and post-flight operations—while providing future-proof compatibility with the XB-30 GPS module.

Secondary Objectives

1. Seamlessly integrate the XB-30 GPS module as a plug-and-play solution for enhanced navigation and future aural alert capabilities.
2. Ensure real-time data accuracy via sensor calibration based on ISA standards.
3. Deliver accurate altimeter settings (QFE, QNH, QNE) with single-button toggling for maximum usability.
4. Exclude wireless connectivity (Bluetooth, Wi-Fi) to comply with FAA regulations.

Business Goals

1. Establish the XB-70 Pro as the standard flight computer for aviation training programs, educational institutions, and professional pilots.
2. Build a scalable product capable of integrating with future accessories to meet evolving market needs.

3. Features and Functional Requirements

3.1 Pre-Flight Planning

The pre-flight planning functionality is centralised in the Pre-Flight Planning Tile, which consolidates tools to optimise navigation, performance, and operational efficiency. The tile is divided into three core sections: GEN NAV, RAD NAV, and T/O PERF.

GEN NAV Tile – Core Navigation Calculations

- Speeds: Calculates TAS, CAS, groundspeed, and Mach number.
- Altitude: Displays QFE, QNH, QNE metrics, including true and density altitude.
- Climb/Descent & Glide: Provides climb/descent rates and glide efficiency.
- Great Circle & Rhumb Line: Calculates long-distance bearings and paths.
- Time & Chart: Converts time zones and chart distances.
- Winds & Drift: Analyzes drift angles, wind corrections, and runway-relevant components.

RAD NAV Tile – Instrument Flight Rule (IFR) Support

- Frequency, Wavelength, and Cloud Base Calculations: Derives radio navigation parameters and weather-related metrics.
- Compass Heading: Displays True, Magnetic, and Compass headings with adjustments.

- ADF/NDB Support: Computes bearings for automatic direction-finding navigation.
- VOR/DME Calculations: Supports radial navigation and reverse sensing detection.
- ILS & ROC/D: Guides Instrument Landing System (ILS) approaches and computes rates of climb/descent.
- Holding Patterns & Radial Intercept: Assists with holding and radial interception maneuvers.

T/O PERF Tile – Takeoff Performance

- Center of Gravity (C.G): Calculates aircraft balance for safety.
- Takeoff Weight (TOW): Computes MTOW and other weight metrics.
- Fuel Calculations: Converts fuel between volume and mass.
- Point of Equal Time (PET): Determines equal travel time points.
- Point of Safe Return (PSR): Calculates maximum safe return distance.
- V-Speeds: Derives critical takeoff/landing speeds, including V1, VR, and V2.

3.2 In-Flight Instrumentation (Cockpit Mode)

The cockpit mode emphasizes real-time instrumentation with a 20Hz refresh rate and ≤50ms display lag.

- Altitude & VSI: Dynamic altitude readings calibrated for Non-ISA Temperature.
- AHRS (Attitude, Heading, Reference System): Displays attitude, pitch, and roll in real-time.
- Weather Data Display: Includes OAT, relative humidity, and pressure settings.
- Groundspeed & G-Force: Real-time performance metrics for situational awareness.
- XB-30 GPS Integration: Provides precise navigation capabilities with future aural alerts.

3.3 Post-Flight Data Analysis (FDA)

- SD Card Storage: Stores flight data securely for analysis, with exam-mode restrictions.
- USB-C Data Transfer: Enables fast data export for detailed post-flight analysis.

3.4 User Interface and Customization

- 2x3 Matrix UI: Lumia-inspired, intuitive layout for easy navigation.
- Theme Settings: Predefined themes allow users to personalize the interface.
- Altimeter Toggle: One-button toggle between QFE, QNH, and QNE settings.

3.5 Display and Input

- Display: 3.5” IPS MIPI (640x480) with anti-glare coating and ≤50ms lag.
- Keypad: 6x6 tactile matrix for quick input, with dedicated power button.

3.6 Battery and Power

- Battery: 3.7V 2500mAh Lithium-ion for 4+ hours of continuous cockpit operation.
- USB-C Interface: Supports charging, data transfer, and includes circuit protection.

4. Technical Specifications

- Microcontroller: STM32H747/57AI for high-speed processing.
- **Sensors:**
  - Bosch BMP585: Altitude and VSI with ISA calibration.
  - Bosch BHI360: AHRS and G-force monitoring.
  - Sensiron SHT45AD1F: Environmental sensors for accurate weather data.
- Dimensions: ~100mm x 50mm x 15mm with soft-touch plastic enclosure.

5. Performance Requirements

- Data Refresh Rate: ≥20Hz with ≤50ms lag.
- Battery Life: ≥4 hours in cockpit mode.
- Data Transfer: Fast SD card and USB-C support.

6. Risks and Mitigations

- Battery Life: Swappable battery option mitigates longer flight risks.
- Sensor Drift: Includes user calibration options for AHRS and barometric sensors.
- Display Lag: MIPI interface ensures minimal lag.

7. Future Considerations

- XB-30 Module Updates: Future versions to include a speaker for aural alerts.
- Additional Sensor Compatibility: Expand support for new sensors to enhance accuracy.

8. Conclusion

The Airman XB-70 Pro Flight Computer represents a new standard in flight instrumentation, delivering real-time data accuracy, seamless GPS integration, and versatile pre-flight and post-flight capabilities. Its intuitive design, regulatory compliance, and modular expandability make it the perfect solution for student, hobby, and professional pilots alike.

Scope of Work (SOW)

Project Name: Development of Airman XB-70 Pro Flight Computer

Version: 012

Date: October 21, 2024

Prepared By: Airman Development Team

1. Project Overview

The Airman XB-70 Pro Flight Computer is a next-generation flight planning and instrumentation device designed to enhance pre-flight planning, in-flight navigation, and post-flight data analysis. This project involves designing, developing, and delivering a fully functional flight computer that integrates with the modular XB-30 GPS module while maintaining FAA-compliant standards.

The scope includes hardware and software development, testing, and deployment of the XB-70 Pro, along with technical documentation and user support systems.

2. Objectives

1. **Primary Deliverable:**
    - A fully functional Airman XB-70 Pro Flight Computer.
2. **Specific Objectives:**
    - Develop modular support for the plug-and-play XB-30 GPS module.
    - Build a 2x3 matrix user interface with customizable themes and predefined modes.
    - Integrate precise pre-flight planning and in-flight navigation tools.
    - Achieve FAA exam and cockpit compliance by excluding wireless connectivity.
    - Provide detailed post-flight analysis functionality.

3. Deliverables

3.1 Hardware

1. **Flight Computer Unit:**
    - **Core Components:**
        - STM32H747/57AI Microcontroller.
        - Sensors: Bosch BMP585 (Altitude/VSI), BHI360 (AHRS/G-force), Sensiron SHT45AD1F (Environmental).
        - Display: 3.5” IPS MIPI (640 x 480) with anti-glare coating.
        - Battery: 3.7V 2500mAh Lithium-ion (4+ hours runtime).
        - Enclosure: Soft-touch plastic with injection molding.
2. **Interfaces:**
    - SD Card for FDA storage.
    - USB-C port for data transfer, GPS connectivity, and charging.
3. **Input:**
    - 6x6 tactile keypad matrix with a dedicated power button.

3.2 Software

1. **Pre-Flight Planning Tools:**
    - **GEN NAV Tile:**
        - Speed calculations: Groundspeed, TAS, CAS, and Mach number.
        - Altitude metrics: QFE, QNH, QNE with comparative matrix displays.
        - Navigation paths: Great Circle and Rhumb Line calculations.
        - Wind corrections and drift analysis.

- **RAD NAV Tile:**
  - ADF/NDB Calculations: Bearings (QDM, QDR, QUJ, QTE).
  - VOR/DME Calculations: Bearings with reverse sensing detection.
  - Compass Heading adjustments: True, Magnetic, and Compass Heading.
  - Instrument Landing System (ILS) guidance.
- **T/O PERF Tile:**
  - C.G and TOW calculations.
  - Fuel planning and mass/volume conversions.
  - PET and PSR distance/time calculations.
  - V-speeds derivation for takeoff and landing.

2. **Cockpit Mode Features:**
   - Real-time AHRS: Attitude, pitch, and roll.
   - VSI, altitude, and weather data (OAT, humidity, pressure).
   - Integration with XB-30 GPS for navigation and future aural alerts.
3. **Post-Flight Analysis Tools:**
   - Flight data export via SD card and USB-C.
   - Secure FDA mode ensuring restricted access during exams.

3.3 Technical Documentation

1. User manuals for flight computer operation.
2. Technical specifications document.
3. Installation and maintenance guides.

4. Scope of Work

4.1 Task Breakdown

1. **Design and Prototyping:**
    - Develop hardware prototypes for the XB-70 Pro and XB-30 GPS module.
    - Design the 2x3 matrix user interface with predefined themes.
2. **Hardware Development:**
    - Assemble hardware components, including sensors, microcontroller, display, and power systems.
    - Design and produce injection-molded enclosures.
3. **Software Development:**
    - Develop software modules for GEN NAV, RAD NAV, and T/O PERF tiles.
    - Integrate real-time AHRS and environmental sensor data processing.
    - Ensure compatibility with XB-30 GPS for navigation functionality.
4. **Testing and Validation:**
    - Perform hardware testing for durability and compliance.
    - Conduct software validation for pre-flight, in-flight, and post-flight features.
    - Test FAA-compliance for exam and cockpit standards.
5. **Production and Deployment:**
    - Manufacture production-ready units.
    - Package with accessories, manuals, and user guides.

5. Timeline and Milestones

1. **Design Phase: 04 Weeks**
    - Hardware prototyping and interface design.
2. **Development Phase: 04 Weeks**
    - Hardware assembly and software module implementation.
3. **Testing and Validation: 04 Weeks**
    - Hardware durability and software feature validation.

6. Assumptions and Constraints

1. **Assumptions:**
    - The XB-30 GPS module will be ready for integration by the testing phase.
    - Regulatory compliance reviews will not delay project timelines.
2. **Constraints:**
    - No wireless connectivity features (e.g., Bluetooth, Wi-Fi).
    - Must operate reliably in small aircraft cockpits under VFR conditions.

7. Risks and Mitigations

1. **Battery Life:**
    - Risk: Limited runtime during extended operations.
    - Mitigation: Optional swappable battery or power-saving modes.
2. **Sensor Drift:**
    - Risk: Long-term inaccuracies in AHRS or barometric readings.
    - Mitigation: Include user calibration options and high-quality sensors.
3. **Display Lag:**
    - Risk: Potential latency due to high data throughput.
    - Mitigation: Optimize software for MIPI display interface and real-time performance.

8. Acceptance Criteria

The Airman XB-70 Pro will be considered complete and ready for delivery when:

1. All hardware and software modules meet defined specifications.
2. The system passes FAA compliance testing for exam and cockpit use.
3. Pre-flight, in-flight, and post-flight functionalities are validated through user testing.
4. Comprehensive user documentation is provided with the final product.

9. Budget

To be detailed based on hardware costs, development effort, and production scaling.