

KFT Ground Control Station (GCS) Software Specification

This document provides a comprehensive system architecture and functional breakdown of the **KFT GCS Software**, derived directly from the system user manual. The software serves as a cross-platform mobile operator interface designed to initialize, plan, calibrate, and execute agricultural drone operations.

1. Access & Network Topology Specifications

User Management Protocols

- **Data Fields Required for Registration:** First Name, Last Name, Email ID, Mobile Number (prefixed with matching country code), and Account Password.
- **Access Lockout Interlocking**
: Accounts require explicit administrator authorization following sign-up. Unauthorized entry blocks access to subsequent connectivity features.

Wireless & Network Interface Configuration

Operators can establish a communication link with the flight vehicle through two primary routing layers:

- **TCP Link:** Requires field population of an IP Address (Default template: 10.0.2.2) and an incoming routing Port Number (Default benchmark listener: 5762).
 - **Bluetooth Link:** Utilizes a proximity scanning protocol to identify and pair with available onboard radio hardware.
 - **USB:** Can Connect to flight controller using usb for log downloads.
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2. Telemetry, Map Display, & Live Operation Specs

Live Flight Status Interface

Upon successful authentication and vehicle handshake, the central telemetry panel monitors and records five continuous real-time diagnostic parameters:

- **Voltage:** Real-time battery potential.
- **Current:** Direct current load measured in Amperes.

- **Satellite Count:** Total global navigation satellite system (GNSS) links.
- **HDOP:** Horizontal Dilution of Precision tracking spatial GPS coordinate quality.
- **Interlock State Flag:** Clear binary confirmation status of whether the propulsion layout is **Armed** or **Disarmed**.

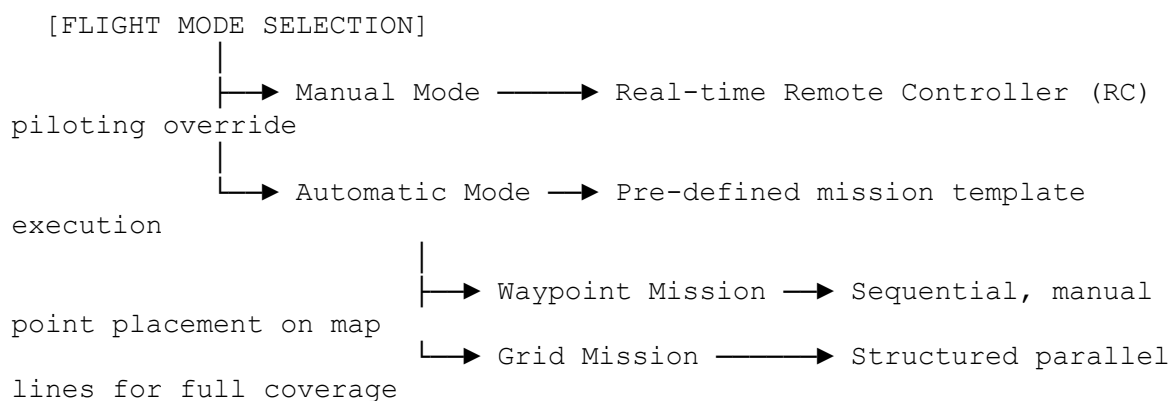
Terrain Visualization Formats

The spatial interface map sub-system supports dual view toggling:

- **Road Map:** A vectorized, standard cartographic reference detailing ground infrastructure and transit pathways.
- **Satellite Map:** High-resolution, real-world imagery used for detailed terrain and crop perimeter evaluation.

3. Flight Mode Mechanics & Spatial Mission Planning

The software partitions navigation logic into two operational streams based on field requirements:



Grid Survey Data Ingestion Options

When establishing a complex field survey pattern, the app ingests or generates spatial boundaries through four processing paths:

1. **KML Import:** Parses external `.kml` boundary files containing pre-surveyed field coordinates to generate automated flight sweeps.
2. **Map Draw:** Allows the operator to manually place and manipulate boundary polygon vertices directly on the screen.
3. **Drone Position:** Uses the real-time coordinates of the aircraft as the geometric reference point for mission planning.
4. **RC Position:** Pins the location of the remote controller to help maintain line of sight and manage safe transmission ranges.

Dynamic Mission Generation Variables

When a grid path is generated inside an active boundary, the operator can customize five system settings to alter path geometry and efficiency:

- **Line Spacing:** Measures the physical distance between parallel grid passes (4.3 m target default in templates).
 - **Grid Angle:** Rotates the heading of the parallel flight tracks (85° or 0° orientation benchmarks).
 - **Speed:** Manages the forward velocity vector during a mission leg (1 m/s reference baseline).
 - **Altitude:** Dictates the operational height above ground level.
 - **Indentation (Margin):** Controls the safety buffer distance between outer flight lines and the defined perimeter edge.
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4. Agricultural Spraying & Payloads Management

Dynamic Application Rate Tuning

- **Flow Variation Panel:** A dedicated interface overlay allows manual adjustments to fluid delivery rates on a sliding percentage scale (0% to 100%).
- **Live Metrics Overlay:** Continuously monitors the fluid system's performance, displaying real-time information on active flow status, total area treated in acres, and fluid volume consumed.

Obstacle Avoidance & No-Spray Buffers

- **Dynamic Vertex Mapping:** Operators can map unexpected field obstacles (such as poles, trees, or structural hazards) by placing points on the map.
- **Localized Flow Suspension:** The software calculates a cylindrical exclusion mask using an adjustable radius slider around the hazard. The drone safely traverses the grid path but dynamically cuts spraying inside the obstacle boundary, automatically resuming application once past the buffer.

Mission Control Protocols

- **Live Tracking & Camera Views:** A split-screen mode displays the drone's position as a blue marker on the map while showing a real-time video feed in the bottom-right corner.
 - **Interrupt & Resume-Point Saving:** If a mission is paused (e.g., for a battery swap or fluid refill), the system automatically saves the interruption point. The operator can then confirm the designated resume waypoint to send the drone back to its exact last position, preventing skipped rows or overlapping coverage.
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5. System Calibration Matrices

Configuration and hardware calibrations are managed within a modular settings interface.

Core Sensor Calibrations

1. **IMU / Accelerometer Calibration (6-Position):** Validates balance and internal sensor structures. The drone must remain stationary on a level surface while being rotated through six distinct orientations: ◦ Position 1: Level (Flat) ◦ Position 2: Left Side ◦ Position 3: Right Side ◦ Position 4: Nose Up ◦ Position 5: Nose Down ◦ Position 6: Reverse (Upside Down)
 - *Post-Condition:* Requires a system reboot command to apply the updated calibration profiles.
2. **Compass Calibration:** Requires rotating the vehicle outdoors away from metallic structures or magnetic interference. The software disables the saving function until the data gathering progress reaches at least a **70% baseline**, requiring a full **100% completion profile** before enabling a hardware reboot.
3. **Barometer Calibration:** Calibrates the altitude baseline by sampling atmospheric pressure while the vehicle sits completely motionless on a flat, wind-sheltered surface.

Spray Subsystem Diagnostic Tools

The liquid delivery system features a dedicated calibration panel containing four tools:

- **Flow Sensor Calibration:** Calibrates volume parameters via a physical bucket test to determine the exact scaling factor (`BATT2_AMP_PERVLT` link).
- **Level Sensor Calibration:** Captures raw sensor outputs at empty and full liquid levels to enable accurate tank-volume tracking.
- **Pump Calibration:** Configures the auxiliary pulse width modulation (PWM) range of the primary fluid pump (`Servo9` logic path).
- **Spray System Test:** Executes a full end-to-end diagnostic sweep of the pump, flow sensors, and fluid lines to confirm system health.

RC Interface Channel Mapping

Maps inputs from a connected controller to ensure the flight deck registers standard command movements. It benchmarks and calibrates four core flight control signals:

- **Roll (Channel 1):** Lateral movement axis (1500 μ s center point).
- **Pitch (Channel 2):** Longitudinal movement axis (1500 μ s center point).
- **Throttle (Channel 3):** Vertical thrust axis (1000 μ s baseline lower floor).
- **Yaw (Channel 4):** Rotational orientation axis (1500 μ s center point).

6. Failsafe Management & Data Lifecycle

Contingency Action Protocols

Operators configure automated safety behaviors for two major operational events:
Trigger Condition

Selectable Safety Action Profile Options Event	
Mission	Hover (Stationary loiter at terminal point) RTL (Automated return to Completion launch point) Land (Forced touchdown at location)
Tank Empty Detection	Hover (Halt pathing for operator attention) RTL (Return home for fluid replenishment) Land (Immediate descent)

Operational Log Retrieval

- **Telemetry Storage:** Saved profiles track past project details (such as project title and unique plot designations like `Field Survey 1` or `Plot A / Farm 12`).
- **Data Fields Captured:** Records include mission date, time stamps, distance covered, and payload data. The system includes an **Export All** function to download these logs for analytical review and historical operational compliance.