SA 180 UAV
KAMIKAZE SYSTEM

Content

1. Overview

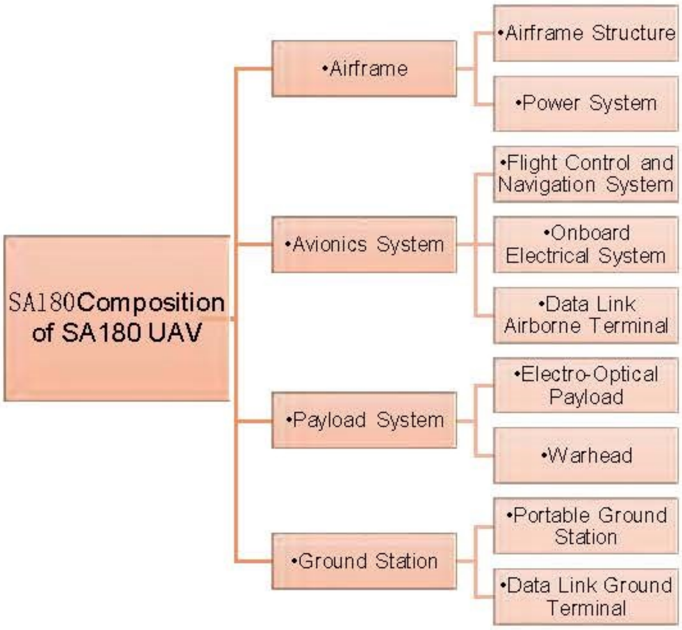
The SA180 is a versatile, long-endurance unmanned aerial vehicle designed for a wide range of missions. It is powered by a piston-type aviation engine, offering extended flight duration and excellent fuel efficiency, making it ideal for sustained surveillance, reconnaissance, and patrol operations.

The system utilizes a rocket-assisted launch mechanism and features a delta-wing configuration, allowing for quick deployment and enhanced aerodynamic performance. With a gyroscopically stabilized electro-optical payload and long-range data link, the SA180 provides reliable real-time intelligence capabilities.

Designed with a modular universal platform and a large hatch-type payload bay, the SA180 supports fast equipment upgrades or replacements to meet evolving mission requirements. Its design emphasizes standardization, maintainability, and cost-efficiency, ensuring high reliability and a low total life cycle cost. It is minimally affected by terrain and can operate continuously, day and night.

2. System Composition and Technical Specifications

2.1. System Composition



2.2. Technical Specifications

- Operating Environment: Suitable for both maritime and land use
- Propulsion: Piston-type aviation engine
- Payload Capacity: 50 kg
- Endurance: 14 hours
- MTOW:200kg
- Cruising Speed: 50m/s
- Cruising Altitude: 2,000–3,000 meters
- UAV Dimensions (L × W × H): 3.05 m × 2.8 m × 0.65m
- Fuel Tank Capacity: 90 liters
- Max Range：≥ 2400km
- Flight Altitude Range: 0 to 5,000 meters
- Wind Resistance: ≥ Level 6

- Operating Temperature Range: –20°C to 50°C
- Aerodynamic Configuration: Flying wing design

3. Propulsion System

3.1. Power Required for Level Flight

Let the average mass of the UAV in level flight be denoted as m_{pj} . The required power for level flight is calculated as:

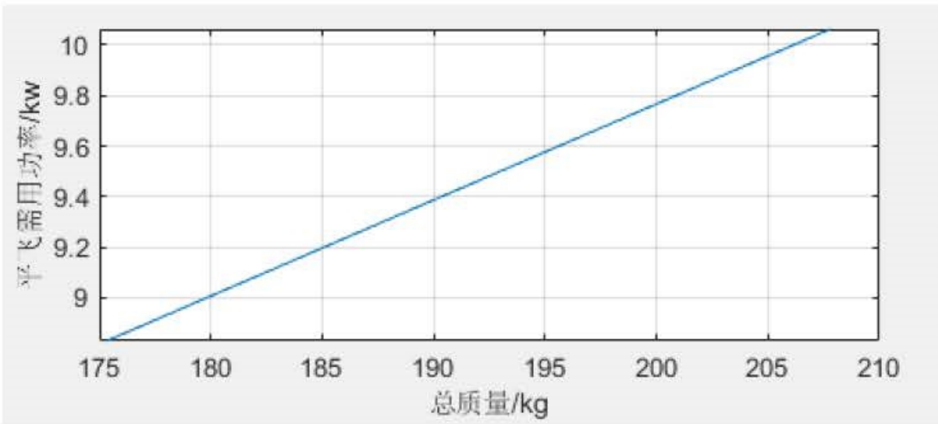
$$P = \frac{mg}{K} \cdot V$$

Where:

- m is the UAV's mass
- g is gravitational acceleration
- K is the average lift-to-drag ratio
- V is the cruise velocity

Assuming a reference lift-to-drag ratio K=6.5K = 6.5K=6.5, typical for similar UAVs, and varying UAV takeoff weights, the corresponding required power for level flight is plotted in the accompanying chart.

At a takeoff weight of 190 kg, the required level flight power is approximately 9.4 kW.



Power-mass curve

3.2. Required Power of the Engine

Assuming a propeller propulsion efficiency η= 0.6, the engine shaft power is:

$$P_e = \frac{P}{\eta}$$

Using the above relationship and a takeoff mass of 206 kg, the average shaft power required by the engine in level flight is approximately 13.77kW.

3.3. UAV Fuel Consumption per Hour

Assuming the engine's specific fuel consumption (SFC) is:

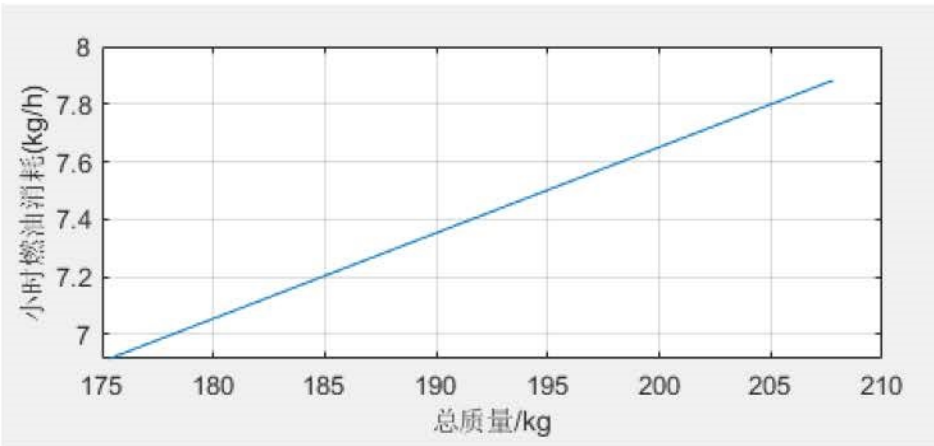
$$SFC=0.4kg/(kW\backslash h)$$

Then the fuel consumption per hour is:

$$M_h=SFC*P_e$$

Using the above values, when the total UAV weight is 190 kg, the average hourly fuel consumption is about 7.2 kg/h.

This relationship is plotted in the fuel consumption curve diagram.



3.4. Engine Parameters

To meet short takeoff requirements and ensure reliability, a 550cc piston engine is ultimately selected. The engine specifications are summarized as follows:

Parameter	Value
Working Capacity	550 cc
Speed Range	1500–7500 rpm
Maximum Power	37 kW @ 7500 rpm
Cooling Form	Natural air cooling
Ignition Mode	CDI electronic ignition
Operating Voltage	12–14 V
Propeller Rotation	Clockwise (facing the propeller)
Fuel Type	95# gasoline, 40:1 fully synthetic lubricant
Starting Mode	Electric start
Fuel Supply Mode	Omnidirectional pump film carburetor
Control Mode	Servo motor (7.4–12 V)
Power-to-Weight Ratio	1.85 kW/kg
Total Weight	20 kg (including electric starter)
Dimension	301 × 420 × 352 mm
Recommended Propeller	28×24 · 34×18
TBO (Time Between Overhaul)	300 h

4. Flight Control System

The architecture of the flight control system directly impacts its functionality and performance. A user-friendly and extensible system design facilitates capability implementation. As UAVs are unique controlled objects, the system must ensure real-time performance, high accuracy, and stability.

Small UAV flight control systems are limited by constraints such as size, weight, power consumption, and installation space. Therefore, the design follows principles of usability, appropriate accuracy, high integration, and ease of installation, with some hardware requirements being fulfilled through software.

4.1. Hardware Design

4.1.1. Functional Requirements

a) CPU: Must handle tasks such as sensor data processing, remote control/telemetry management, and multi-modal control law computation.

b) Manual/Auto Mode Switching: Switchable via RC toggles or ground station commands to assign flight control authority. Manual mode and RC must power on synchronously.

c) PWM Signal Processing: Since RC equipment uses PWM, the flight controller must support PWM decoding and generation.

d) Data Logging: Real-time recording of flight parameters, preset routes, and control commands.

e) Power Management: Provide safe, reliable, and appropriately rated power to all subsystems.

f) Safety Monitoring: Includes monitoring critical flight safety signals (voltage, current, engine speed, cabin temperature), and providing emergency interfaces.

4.1.2. Design Principles

The hardware of the flight control and management system is the foundation for implementing navigation control algorithms, mode switching, and route/mission management. Key focus areas include:

- Simplicity and practicality: Minimize intermediate processing steps in signal and power flows; favor sensor data reuse and streamlined circuitry.
- Appropriate accuracy: Match precision to functional needs without overengineering.
- High reliability: Critical modules (power, manual/auto switching, sensors) may use redundancy; ensure robust hardware connections.
- High integration: Maintain strict control over volume, weight, and power; use high-efficiency DC-DC converters.
- Modular and scalable: Support upgrades and ease maintenance.

4.1.3. Hardware Architecture

Key hardware components:

- Sensor Module: INS, barometric and airspeed sensors
- I/O Module: RC receiver (SBUS), PWM input/output
- Analog Processing Module: Monitors power supply voltage, current, servo voltages, etc. Uses independent high-precision ADCs to reduce interference.
- Power Supply Module: Supplies regulated voltage for the control system
- Communication interfaces：include SPI, UART, and I²C for data transfer.

4.1.4. Flight Control Technical Specifications

Category	Parameter	Specification
System Performance	Attitude Precision	1°
	Heading Precision	0.2° (1m baseline)
	Position Accuracy	Single point: 1.5 mRTK: 0.8 cm
	Angular Velocity Measurement Range	±500°/s
	Acceleration Measurement Range	±4 g
	Height Measurement Range	-500 m to 10,000 m
	Voltage Monitoring Range	0 – 52 V
	Servo Updating Frequency	50 Hz
	Engine Speed Monitoring Range	0 – 20,000 RPM
	Voltage Monitoring Channels	2 channels
	Engine Speed Monitoring Channels	2 channels
	PWM Control	9 channels
	Digital Output	3 channels (PWM programmable)
	Expansion Serial Ports	3 channels (e.g. RTK, payload, etc.)
	SBus Input	1 channel
	Flight Routes	8 routes (800 waypoints per route)
	Built-in Data Logger	9 hours
	Photographing Points	10,000 points
	Emergency Landing Points	100 points
Communication Interface	Interface Type	RS-232C
Electrical Parameters	Power Supply Voltage	DC 4.5 – 9.0 V
	Power Consumption	< 3.5 W
Physical Parameters	Weight	150 g
	Dimensions	109 × 56 × 32.5 mm
Environmental Parameters	Working Temperature	-40°C to +55°C
	Storage Temperature	-40°C to +85°C

4.1.5. MEMS IMU

The Autopilot can be connected to an external IMU inertial navigation system, and in the presence of interference, it can fly in pure inertial navigation mode.

LR100 MEMS Inertial Measurement Module(referred to as LR100 below) is a general-purpose, miniaturized industrial-grade inertial measurement unit (IMU) that includes a three-axis gyroscope and a three-axis accelerometer. By applying temperature compensation to the zero bias and scale factor of each axis, as well as compensating for cross-axis misalignment between each pair of axes, the module significantly improves the accuracy of actual measurements.

By default, the LR100 MEMS Inertial Measurement Module outputs IMU data in a timed broadcast mode at a frequency of 200 Hz. Each data frame consists of 40 bytes. The default communication settings are:

- Baud rate: 115200 bps
- Data format: 1 start bit, 8 data bits, 1 stop bit, no parity
- Byte order: little-endian (low byte sent first)

The communication baud rate and output frequency are customizable according to user requirements, with a maximum baud rate of 921600 bps and a maximum output frequency of 1000 Hz.

Category	Parameter	Specification
Gyroscope	Measurement Range	±500 °/s
	Zero Bias over Full Temp (1σ)	≤ 0.05 °/s (XY), ≤ 0.01 °/s (Z)
	Zero Bias Stability (1σ)	≤ 10 °/h (XY), ≤ 5 °/h (Z)
	Zero Bias Instability (Allan, TYP)	2 °/h (XY), 0.5 °/h (Z)
	Angle Random Walk	≤ 0.25 °/√h
	Scale Factor Nonlinearity	≤ 100 ppm
	Threshold / Resolution	≤ 0.005 °/s (XY), ≤ 0.001 °/s (Z)
	Bandwidth	80 Hz
	Acceleration Sensitivity	≤ 10 °/s/g
	Cross-Axis Sensitivity	≤ 0.05 °
Accelerometer	Measurement Range	±16 g
	Zero Bias over Full Temp (1σ)	≤ 2 mg

Category	Parameter	Specification
	Zero Bias Stability (1σ)	≤ 0.3 mg
	Zero Bias Repeatability	≤ 0.3 mg
	Scale Factor Nonlinearity	≤ 300 ppm
	Threshold / Resolution	≤ 0.1 mg
	Bandwidth	80 Hz
	Cross-Axis Sensitivity	≤ 0.05 °
Electrical / Mechanical	Power Supply	DC 3.3V
	Power Consumption	< 0.8 W
	Communication Interface	UART
	Output Rate	Default 200 Hz, Max 1000 Hz
	Dimensions	25 mm × 28 mm × 10 mm
	Weight	< 15 g
Environmental	Operating Temperature	-40°C to +85°C

4.2. Software Design

4.2.1. Functional Requirements

The embedded software system for flight control and management is the core of the onboard platform. It handles:

- Sensor Data Processing: Executes sampling, preprocessing, digital filtering, and multi-sensor fusion to determine 3D position, acceleration, Euler angles (attitude), angular velocity, airspeed, and ground speed.
- Autonomous Flight Control: Implements control algorithms for attitude, altitude, speed, yaw deviation, and flight path, including control mode switching and transition handling.

- Flight Management: Manages RC commands, telemetry feedback, flight state transitions, navigation, route planning, and data recording.
- Mission Management: Controls mission equipment (e.g., camera shutter), manages equipment states, and records mission data.
- Control Mode Switching: Interprets PWM signals from RC mode switch channel to switch between manual/autonomous control.
- Status Monitoring & Emergency Protection: Performs power-on self-checks and monitors critical parameters (engine RPM, voltage, current, temperature, etc.), triggering automated safeguards as needed.
- Remote Communication & Safety Monitoring: Uses Iridium satellite module for remote control and periodic telemetry beyond standard link range.
- Ground Control Software Integration: Supports route planning, mission programming, remote commands, parameter display, status alerts, onboard parameter configuration, and data playback.

4.2.2. Software Architecture and Execution Sequence

The software is structured into three hierarchical layers:

- Planning Layer: Manages user interaction, parameter configuration, and mission planning (executed by the ground station).
- Behavior Layer: Converts high-level mission plans into UAV actions (e.g., takeoff, hover, climb). Runs onboard.
- Action Layer: Translates behavioral commands into actuator-level instructions for attitude control. Also runs onboard.

The Planning Layer (ground station) communicates with the onboard Behavior Layer via DART serial protocol. Data is received using serial interrupts.

Execution Frequencies:

- Inner-loop control: 25 Hz
- Outer-loop control: 10 Hz
- Other software modules follow these timing baselines, adjusted according to

computational requirements.

4.2.3. Functional Modules

Key modules of flight management include:

a) Flight State Management

- Mode switching (manual, semi-autonomous, fully autonomous) via RC toggles
- Mode transitions processed via PWM interpretation

b) Remote Control & Telemetry

- Telemetry: Managed by the ground station, receives data via wireless link and displays real-time values
- Remote Control: Ground station sends commands to onboard system via wireless link; commands are parsed and executed onboard
- All communications follow a predefined protocol standard

c) Navigation Control & Management

- Computes position, heading, and deviation for outer-loop feedback
- Supplies target altitude and heading values

d) Route Programming & Management

- Performed on ground station
- Uploaded missions are decomposed onboard into heading/attitude tasks
- Waypoint switching can be real-time or automatic

e) Flight Data Logging

- Flight Data: Automatically recorded from takeoff, used for post-flight analysis
- Mission Data: Logged upon mission trigger, e.g., camera exposure; includes POS data

Three flight control modes are supported:

Mode	Description
Manual Mode	Full manual control via RC (surfaces & throttle); high workload for pilot
Semi-Autonomous	Pilot sets attitude/speed/altitude; system maintains

Mode	Description
	stability automatically
Fully Autonomous	No manual input required; lowest control authority priority; RC can override at any time

Default Mode: Upon system startup, UAV operates in Fully Autonomous Mode.

A robust safety monitoring module is implemented using software logic and sensor inputs. Real-time UAV health data is transmitted via wireless link, providing alerts to the ground operator.

Two levels of protection logic:

- Critical States (e.g., power failure, GPS loss): Immediate autonomous protective actions, non-cancelable.
- Non-critical States (e.g., low fuel): Action configurable via ground station; if disabled, system only issues warnings.

Table – Monitoring Conditions and Protective Measures:

Condition	Protective Measure	Notes
Main battery below return voltage	Return to base	Configurable via ground station
Main battery below emergency level	Emergency landing	Configurable
Low fuel (fuel-powered UAV only)	Return to base	Configurable
Dual engine failure	Emergency landing	Configurable
Single engine failure	Return to base	Configurable
Low GPS accuracy	Altitude hold then (hover), return to base	Always enabled
Abnormal attitude	Emergency landing	Always enabled
Altitude too high	Deploy parachute (if >250 m and parachute equipped)	Always enabled
Low cruise altitude	Emergency landing	Always enabled
Out of control radius	Return to base	Always enabled
Route deviation	Emergency landing / parachute (if >250 m)	Always enabled
FC hardware failure	Return to base	Always enabled
RC failure	Switch to fully autonomous	Always enabled

Condition	Protective Measure	Notes
	mode	
Navigation system failure	Deploy parachute (if equipped)	Always enabled
Communication timeout	Return to base	Always enabled

5. Avionics System

The avionics system ensures the proper functioning of all UAV subsystems and equipment to fulfill mission requirements. It supplies and distributes power and signal connectivity for:

- Power systems
- Telemetry and control systems
- Flight control and management systems
- Navigation systems
- Mission payload systems

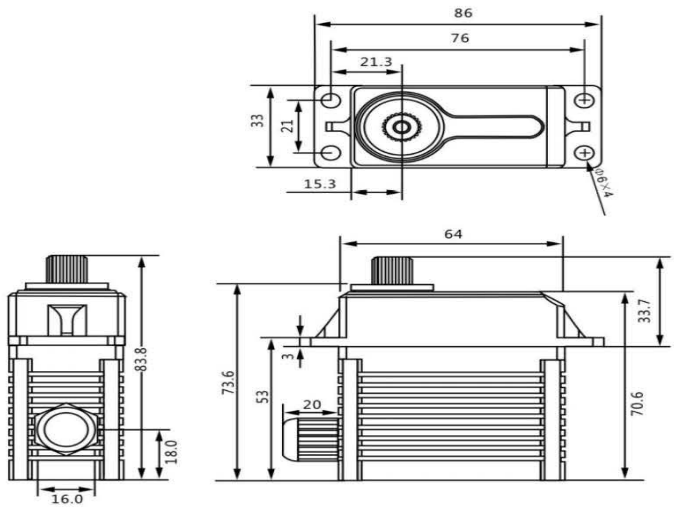
As a critical component of the UAV, the avionics system directly impacts overall reliability and system performance.

The onboard avionics system consists of the following key components:

- Servo actuators
- Wiring (cabling)
- Power modules
- Connectors

5.1. Servo Actuators

All flight surface servos are standardized using the X30-12-150 model, selected based on control surface torque requirements and flight control system compatibility：



X30-12-150

X30-12-150 Servo Specifications:

Parameter	Value
Rated Voltage	DC 12V
Operating Voltage	DC 8.4V–12V
Stall Torque	150 kg·cm @ 12V
Rated Torque	50 kg·cm @ 12V
Stall Current	11 A
Rated Current	2.8 A
No-load Speed	460°/s
Rated Speed	320°/s
Travel Range	±45° (for 1000–2000 μs PWM input)

Parameter	Value
Storage Temperature	–20°C to +65°C

5.2. Cabling

The onboard wiring uses AFR250 silver-plated, high-temperature, ultra-flexible fluoroplastic aviation cables, wrapped in black braided tubing with 5–10% cable length reserve.

Design Notes:

- 50% current capacity margin
- Terminal ends are labeled using heat-shrink tubing
- Shielded cables are used for all critical communication lines to reduce EMI (electromagnetic interference)

Product Name	Ultra-fine Ultra-soft High-temperature Silver-plated Wire
Product Model	AFR-250
Conductor Material	Silver-plated Copper Wire
Rated Voltage	125V, 300V, 600V
Insulation Material	PTFE (Polytetrafluoroethylene)
Rated Temperature	-60°C to +250°C
Standard Length	100 ± 5 meters
Outer Diameter Tolerance	±0.10mm
Test Voltage	2500V

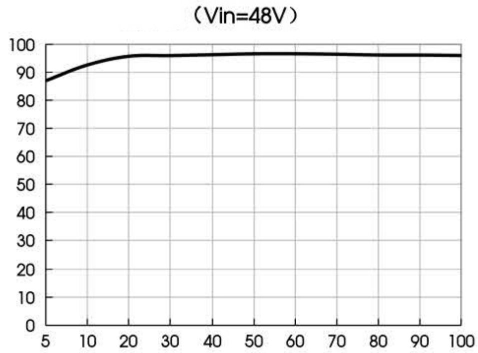
5.3. Power Supply Module

The UAV uses a wide-input, single-output, non-isolated DC-DC power module with the following features:

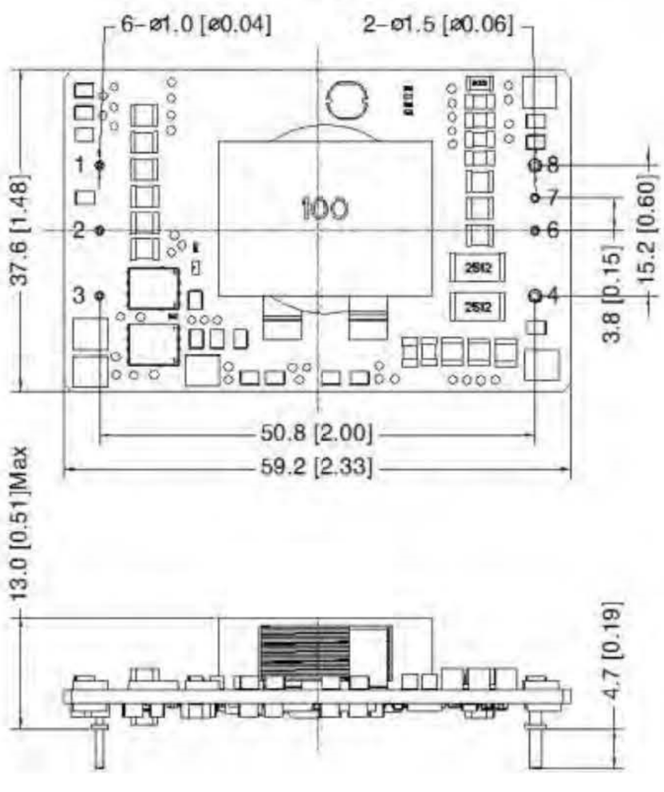
- Output Current: up to 10 A

- Efficiency: up to 97%
- Operating Temperature: –40°C to +85°C
- Protection Features:
    - Input undervoltage protection
    - Output short-circuit protection
    - Output overcurrent protection

Complies with CISPR32/EN55032 CLASS A EMC standards.



Output current and efficiency curve graph



5.4. Anti-jamming Module

5.4.1. Summarize

L125Y_4B1L1E1G1 anti-jamming all-in-one model has 4-channel BDS_B1, GPS_L1, GLO_G1, Galileo_E1 receiving, down-conversion and amplification functions, and it can forward the filtered RF signals to the receiver in a combined way; the product is small in size, light in weight, low in power consumption, simple in application, and it has good electromagnetic compatibility and adaptive anti-jamming processing; it can be widely used in the field of mobile It can be widely used in mobile vehicles, airplanes and unmanned platforms to significantly improve their anti-jamming performance.

5.4.2. Product Features and Uses

This anti-jamming all-in-one machine is highly integrated with BDS_B1, GPS_L1, GLO_G1, Galileo_E1 frequency signal processing module, featuring low noise figure, high gain, good array consistency and small mutual coupling; the antenna components and receiver are independent and interchangeable; it adopts air-time joint adaptive anti-jamming technology, which can simultaneously fight against the interference from three different directions and different types of combinations; it can realize high-precision positioning and accurate timing under strong interference conditions. It can realize high-precision positioning and accurate timing under strong interference conditions.

5.4.3. Main technical indicators

- Antenna array element: 4-way B1/L1/G1/E1;
- Signal Frequency:
  - BSD B1: 1561.098MHz ± 2.046MHz+;
  - GPS L1: 1575.42MHz ± 1.023MHz+;
  - GLO G1: 1601.5 MHz ± 8.5 MHz+;

- Galileo E1: 1575.42MHz ± 1.023MHz+;

- Antenna gain: ≥1dB (ceramic chip array element gain);
- Burn-in resistance: ≥10W;
- Cold start time: ≤60S (including self-test time);
- Hot start time: ≤10 s;
- Lost lock recapture time: ≤3 s (lost lock within 5 s);
- Positioning accuracy: ≤10m;
- Velocimetry accuracy: ≤0.2m/s;
- Power supply and power consumption: input voltage +18V~+32V, stable power ≤22W, transient power ≤28W;
- Anti-jamming ability: can resist broadband, narrowband combination of anti-jamming source number: 3;
  - Single broadband dry signal ratio ≥ 100dB, (reference signal strength -130dBm);
  - Three broadband dry signal ratio ≥ 90dB, (reference signal strength -130dBm);
  - Narrowband dry signal ratio ≥95dB, (reference signal strength -130dBm);

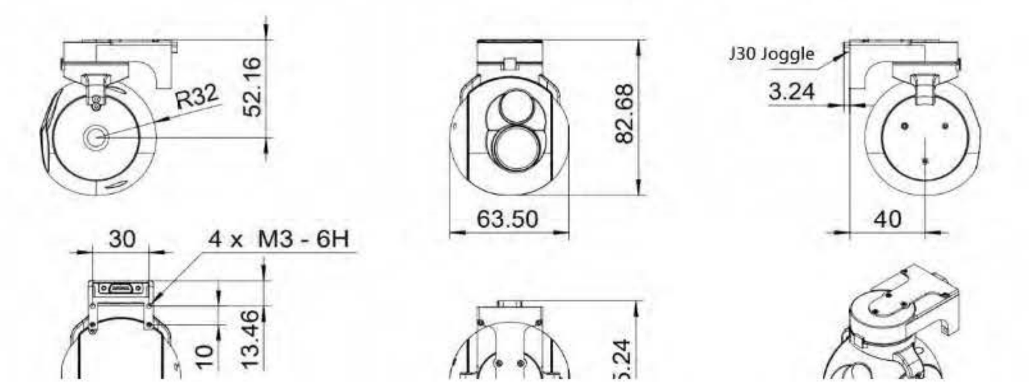
5.4.4. Others

- Structure size: ≤125mm × 125mm × 48mm;

- Weight: ≤540g; (Magnesium alloy version) can be customized.
- Mean Time Between Failures (MTBF) ≥ 5000 hours;

- Mean Time to Repair (MTTR) ≤ 20 minutes;
- Operating temperature: -40℃~+45℃, 10%~90%RH (no condensation);
- Storage environment: -45℃~+50℃, 10%~95%RH (no condensation);

5.5. Seeker



PLD80 High-performance Stabilized EO/IR Gimbal System Features:

- The structure is extremely light and weight less than 280g
- Anti-emission impact
- With servo stabilization function
- Built-in target tracking features
- Wide voltage pressure of 14~28V input, dynamic power consumption control
- All electronic devices are integrated with the metal case packaging, in accordance with the EMC design specifications

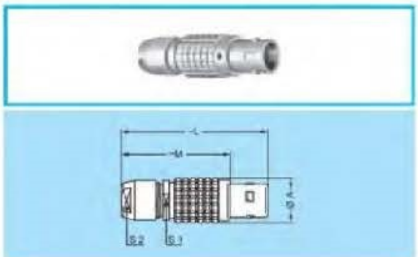
Category	Parameter	Specification
System	System Type	Gyro Stability
	Weight	≤ 280 g
System Features	Platform Type	Two-axial
	Yaw Range	-90° to +90°
	Pitch Range	-90° to +30°
	Max Angular Velocity	≥ 60°/s
	Max Angular Acceleration	≥ 90°/s^2
	Angular Position Accuracy	≤ 0.3°
Electro-Optic (8mm)	Resolution	2560 × 1440 @ 60 fps
	Field of View (FOV)	51° × 30°
Thermal IR (18mm)	Resolution	640 × 512 @ 60 fps
	Field of View (FOV)	24° × 18°
Target Tracking	Frame Rate	60 Hz
	Tracking Speed	±48 pixels/frame
System Interface	Control Interface	RS232 / RS422
	Video Output	Network / RS422
Power Supply	Supply Voltage	14 – 28 V
	Power Consumption	Average ≤ 10 W, Max ≤ 20 W
Environmental Conditions	Operating Temperature	-40°C to +60°C
	Storage Temperature	-50°C to +70°C
	Launch Impact	≥ 400 g

5.6. Connectors

All platform components use LEMO push-pull connectors for electrical interfaces.

Key features:

- Anti-misconnection design
- Waterproof and salt-fog resistant
- Fully compliant with overall UAV environmental and mechanical requirements



FGG

编号		尺寸 (mm)				
型号	系列	A	L	M	S1	S2
FGG	00[1]	6.4	28.5	20.5	5.5	5
FGG	0B	9.5	36.0	26.0	8.0	7
FGG	1B	12.0	43.0	32.0	10.0	9
FGG	2B	15.0	50.0	38.0	13.0	12
FGG	3B	18.0	58.0	43.0	15.0	14
FGG	4B	25.0	75.0	57.0	21.0	20
FGG	5B	35.0	103.0	78.0	31.0	30

FGG

编号		尺寸 (mm)				
型号	系列	A	L	M	S1	S2
FGG	00[1]	6.4	36.5	28.5	5.5	6
FGG	0B	9.5	35.0	25.0	8.0	7
FGG	1B	12.0	42.0	31.0	10.0	9
FGG	2B	15.0	49.0	37.0	13.0	12
FGG	3B	18.0	56.5	41.5	15.0	15
FGG	4B	25.0	71.0	53.0	21.0	20

6. Telemetry and Ground Control Subsystem

6.1. Data Link

6.1.1. Product overview

D1400-P43 is a self-developed TDD wireless transmission equipment. The product has the functions of real-time interference detection, adaptive frequency selection, adaptive stream, automatic retransmission, and automatic power control, which greatly improves the ability of anti-multipath and anti-interference, and has the characteristics of high reliability, good stability, and low delay.

This product is suitable for firefighting, inspection, monitoring and other scenarios, the transmission distance of 200KM when the environment is good.

6.1.2. Product characteristics

- Support long-distance transmission: 4M code flow can be transmitted up to 200km.
- Supports large bandwidth transmission: Up to 15.1Mbps@10MHz.
- Supports automatic repeater transmission: Supports automatic trunk addition.
- Supports multi-interface design: The device has two network ports and four serial ports, supporting RS232/TTL/RS422/SBUS.
- Supports automatic frequency selection: Automatic detection of interference signals, real-time selection of the optimal frequency point.
- Supports automatic retransmission: Automatic retransmission of burst error data improves data reliability.
- Supports adaptive stream: The channel modulation mode is automatically adjusted according to the signal quality in real time.
- Supports automatic power control: Close range automatic adjustment of transmission power, reduce power consumption.
- Supports automatic antenna selection: According to the occlusion situation, the optimal antenna transmission is selected in real time.
- Supports upstream and downstream dynamic allocation: The bandwidth ratio of the master and slave can be automatically allocated according to the actual amount of data.
- Supports the coexistence of multiple set: Support up to 6 sets of equipment at the same time fixed frequency use.
- Supports the frequency matching function: Software can be used to configure the

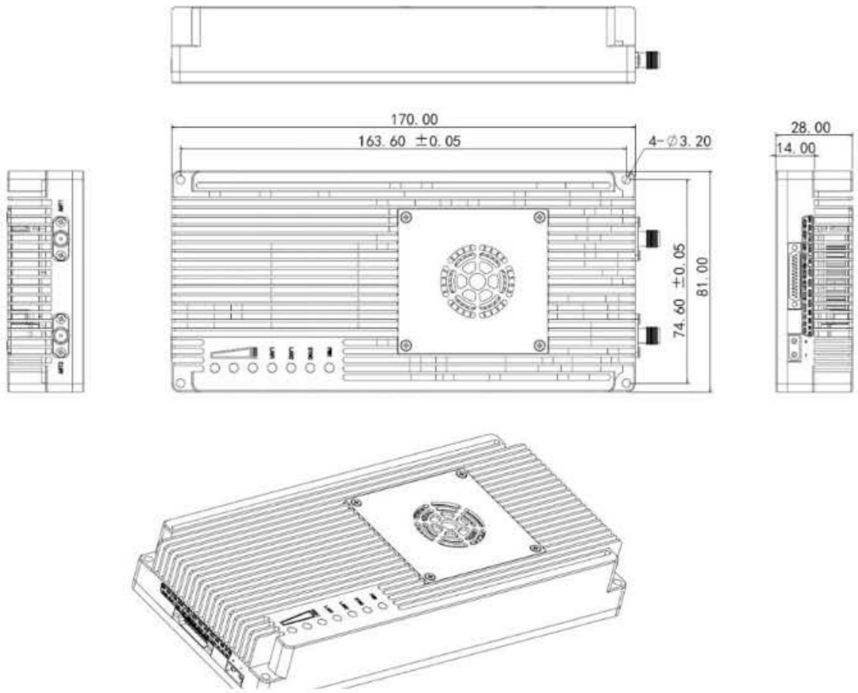
frequency and hardware key frequency.

6.1.3. Product Specification

System parameter	Technical index
Equipment model	D1400-P43
Working frequency	1350~1470MHz (customizable)
Radio frequency	2T2R
Transmission power	43dBm(20W)
Transmission distance	200KM (Air-to-ground LOS)
Channel bandwidth	10MHz
Modulation mode	QPSK/16QAM
Receiving sensitivity	See Table (MCS & Sensitivity)
Speed	15.1Mbps@16QAM3/4
Communication encryption	AES256
Transmission delay	≤10ms
Radio frequency interface	SMAX2
Equipment interface	Ethernet *2
	TTL/RS232 *2
	RS422 *1
	SBUS*2/TTL*1
Overall power consumption	≤ 90W@4Mbps (Air unit)
	≤ 15W@1Mbps (Ground unit)
Dimension(L*W*H)	180mm x 81mm x 28mm
Weight	415g
Working voltage	DC 22~30V, Typical value: 28V@4A
Working temperature	-40°C~+65°C

MCS & Sensitivity (10MHz)			
No.	MCS	Total uplink and downlink throughput (Mbps)	Sensitivity (dBm)
1	QPSK1/3	3.7	-99
2	QPSK1/2	5.3	-98
3	QPSK2/3	6.5	-97
4	QPSK3/4	7.5	-96
5	16QAM1/3	7.3	-96
6	16QAM1/2	10.7	-95
7	16QAM2/3	13.1	-93
8	16QAM3/4	15.1	-91

6.1.4. Dimension diagram



6.2. Ground Station Hardware

a) System Components

The Ground Control Station (GCS) includes both core and peripheral devices:

Core Hardware:

- Ground control computer (ruggedized laptop)
- Ground data link module
- High-brightness display
- Power module

Peripherals:

- Data link antenna
- Antenna tripod
- Interface cables

The GCS supports real-time bidirectional communication with the UAV, providing:

- Remote control (RC) command transmission
- Telemetry data reception and visualization
- System configuration and mission planning

b) System Functions

The GCS is built on a ruggedized, waterproof, dustproof, and shock-resistant laptop platform. Key features include:

- Real-time mission planning and route editing
- Remote command & telemetry data transmission and logging
- UAV flight status monitoring and control
- Intelligence data processing, visualization, and storage
- Map scaling, annotation, and flight path visualization
- Fault detection and real-time warning system

Parameter	Value
CPU	Intel Core i5-2520M
Solid-State Drive	500 GB
Mechanical Hard Drive	500 GB
RAM	8 GB

Parameter	Value
Operating System	Windows 7 / 10
Screen Size	13 inches
Graphics	Integrated (Intel HD 3000 series)
Weight	6.5 kg
Power	External 220V , internal 12V LiPo battery
Operating Temperature	–25°C to +55°C

6.3. Ground Station Software

The ground station software supports both rocket-assisted launch control and in-flight mission operations, enabling:

- Flight control parameter reading and configuration
- Factory default restoration
- Real-time telemetry monitoring
- User-friendly human-machine interface (HMI)

Key Software Features

- Shortcut Toolbar
- Digital Map Panel
- Key Parameter Display
- Command Panel
- Flight Instruments
- Telemetry Subpanel
- RC Command Subpanel
- Data Logging and Playback
- Route and Mission Planning Interface

Software Implementation

Developed using VC++ and C# with object-oriented programming, the system integrates GMAP.NET, which supports:

- Google, Bing, OpenStreetMap, Yahoo, GIS, and other map services
- Geographic visualization
- Thematic analysis
- Spatial queries and geocoding

Map Layers:

- Base Map
- Grid Layer
- Route Layer (for path planning and display)
- Flight Path Layer (auto-purges long trails)
- UAV Icon Layer (dynamic position and heading display),The UAV icon is used to indicate flight mode transitions.