

# Flight Operations Manual



## Four Delta™ Small Unmanned Aircraft System





## **Four Delta Flight Operations Manual**

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Air Robotics has filed utility patent applications on the Airborne Vehicle System, design and utility patent applications on the Modular Payload Lifting System and a utility patent application on the skin system used on this aircraft.

Airborne Vehicle System United States Design Patent D626,490

In that Air Robotics, Inc. has no control over the use of the Four Delta sUAS described in this manual. No liability shall be assumed nor accepted for any damage resulting for the use by the user of the sUAS, the user accepts all resulting liability.

If the buyer is not prepared to accept the full liability associated with the use of this product, the buyer is advised to return the product immediately in new and unused condition to Air Robotics.

Air Robotics, Inc.  
1116 Smith Street  
Charleston, WV 25301

304.807.9464  
[www.airroboticsinc.com](http://www.airroboticsinc.com)  
[info@airroboticsinc.com](mailto:info@airroboticsinc.com)

## Overview

The Four Delta is a blended wing body, payload independent small Unmanned Aircraft System (sUAS) for use in remote sensing, ISR, Cyber/EW, SIGINT, lethal/non-lethal delivery, mapping and airborne scientific applications. It offers payload-independent functionality by virtue of its patent-pending Modular Payload Lifting System™ (MPLS) with over 300 cubic inches of payload capacity in a hand launched sUAS.



Customers using Air Robotics sUAS can swap payloads in just minutes, in the field, allowing them to perform multiple missions using a single airframe. This saves customers time and money by maximizing their time in the air and reducing their airborne platform inventory. The sUAS does not require launch and recovery assets and it offers the highest lift, greatest endurance and most rugged airframe for any unmanned system in its size class.

**Mission Descriptions** - \* Remote Sensing \* Digital Mapping \* Airborne Multi-Spectral Chemical and Pollution Imaging \* Intelligence, Surveillance, Reconnaissance & Target Acquisition (ISRT) \* Battle Damage Assessment (BDA) \* Maritime Intervention Operations (MIO) \* VBSS (Visit Board Search Seizure) \* Search and Rescue \* Port and Coastal Patrol \* Drug Interdiction

**Features** – Payload independent, multi-mission airframe. Patent-pending Modular Payload Lifting System™ (MPLS) pod enables payloads to be field swappable in a matter of minutes – saving customers money and time by not needing to purchase a different sUAS for each specific payload they wish to carry.

## Technical Overview

Payloads – Multiple, customer defined – GTOW 5+ lbs (2.27 kg) hand-launched

Acoustic Signature: Stealth above 250 feet (75 m)

Radio Frequency Transparent Airframe – Low Radar Cross Section. Data, GPS and video antennas can be installed inside of airframe.

Damage Resistance – Impact tolerant, crush-proof, bullet-resistant airframe. Survives falls from over 75 meters.

Propulsion: Electric, brushless

Endurance – Up to 2+ hours

Speed – 10 to 60 knots (18 to 111 km/h)

Operating Altitude (Typ.) - 1000 ft (300 m)

Wing Span – 5.8 ft (1.77 m)

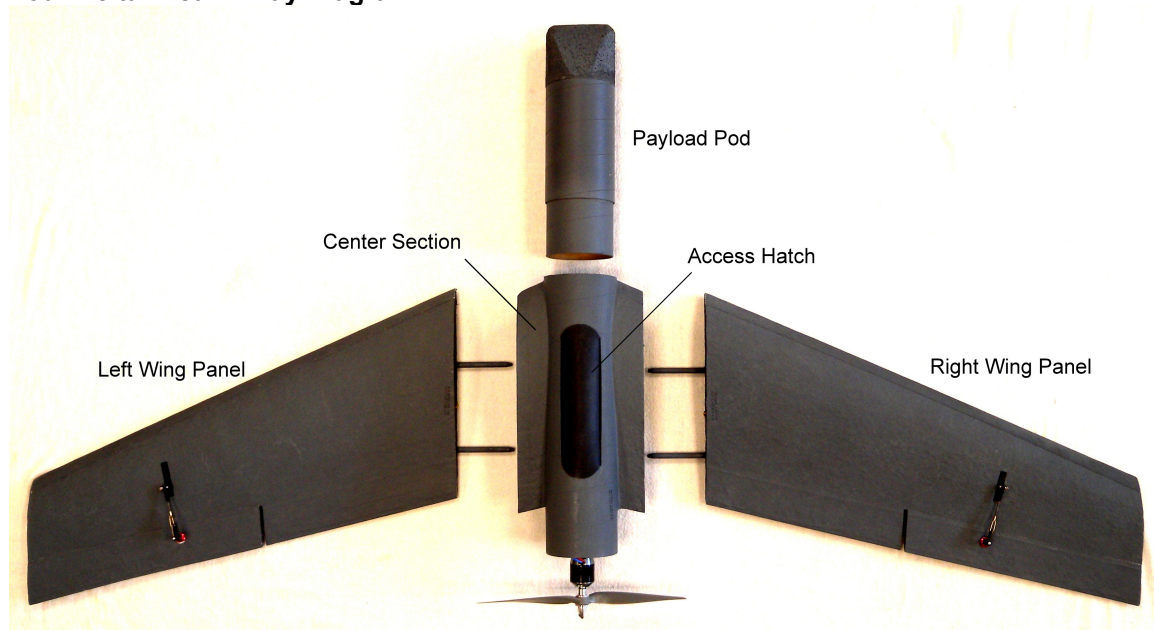
Length - 2 ft (0.6 m)

Weight – Without payload less than 3 lbs (1.36 kg)

Launch Method - Hand-launched

Recovery Method - Belly landing.

## Four Delta Break Away Diagram



The Four Delta consists of four main groups that are interchangeable:

- ⌚ Payload Pod
- ⌚ Center Section
- ⌚ Left Wing Panel
- ⌚ Right Wing Panel

### Group Descriptions

- ⌚ Payload Pod: Contains the payload and in some cases the battery that powers the aircraft.
- ⌚ Center Section: Contains the motor, ESC, RC receiver, autopilot and sometimes the battery that powers the aircraft.
- ⌚ Wing Panels: Contains the servos and servo linkages.

## Balancing - Center of Gravity (CG)

Balancing takes place after the payload pod, batteries and any payload is installed. If the Four Delta is being flown without a payload, ballast will be required in the nose of the payload pod to balance. Ballast such as wheel weights or large fishing sinkers can be secured between the batteries to balance. Slots can also be cut into the nose of the MPLS to install weights. The MPLS nose cone is manufactured from EPS foam so cutting using a hot knife tool or razor knife works well. These slots can be taped over to secure the ballast.

The center of gravity (CG) is located approximately 5.3 inches from the apex of the leading edge along the tube body. On the 1m Four Delta two screw caps are installed on the CG on the underside of the airframe to assist in balancing the aircraft. Placing index fingers on these screw caps and lifting the AVS will provide an indication of whether the Four Delta is nose or tail heavy.

### WARNING

**Never attempt to fly the AVS in a tail heavy state.**  
**NEVER FLY THE FOUR DELTA WITH THE NOSE ABOVE HORIZONTAL.**  
**Check your CG before EVERY flight.**

The nose should be parallel to the ground or pointing down slightly. Most pilots flying the Four Delta in manual mode prefer to fly in a slightly nose heavy state. Do not attempt to fly the Four Delta if the nose is higher than the tail.

### **Transmitter and Autopilot Settings**

- ⌚ Wing Type: Delta
- ⌚ Expo: We recommend -35% expo on both AILERON and ELEVATOR throws.
- ⌚ Differential – We recommend 20%
- ⌚ Servo Throw Percentage: We recommend 80%
- ⌚ Servo linkage lengths- 3 3/8" measured from center of super horn screw to center of servo arm.

### **WARNING**

**Elevon throw must be exactly the same on both elevons  
You must measure elevon throws if you replace a servo or linkage.**

### **Elevon Movement**

The elevons require little movement below the top surface of the wing. This is indicative of the design of a blended wing body aircraft with no vertical surfaces.

### **Set Up for Manual Flying (Radio Control)**

Manual Takeoff trims – In calm wind conditions the elevon should be trimmed 7/8"-1" above the surface of the top of the wing. The reason to set the trims is to allow the pilot who is hand tossing the Four Delta without a helper time to "get on the sticks" after tossing.

Trims will need to be dialed down to around 5/8" once the Four Delta is climbing and throttle reduced to approximately 50%

### **Set Up for Autonomous Flight**

Elevons are neutral at approximately 1/2" above the top surface of the wing. The autopilot will control climb and level the wings during launch.

### **First Flights - Unpowered**

It is recommended that the Four Delta be test flown by tossing it into the wind with no power to the motor. This will provide the new pilot experience in tossing the aircraft.

### **WARNING**

**Do not throw the Four Delta like a football. Do not twist your hand during the throw.  
Throw straight forward and follow through by releasing the aircraft at the top of the throw  
and allowing the hand to continue down in front of your body.**

### **WARNING**

**ALWAYS USE A KEVLAR THROWING GLOVE WHEN TOSSING THE AIRCRAFT.**

You will need to add appropriate ballast to balance the wing on its CG before the first flight. Ballast can be added between the batteries in the MPLS. Trim the elevons so that they are approximately 7/8" to 1" above the trailing edge.

Pick a field where there are no obstructions for 50 yards. Stall speed for the Four Delta is approximately 11 MPH, so choose a day where there is a steady 5 – 10 MPH wind for practicing

throwing. You can test fly in higher winds but the wing will have a tendency to float and this can be somewhat unnerving for a new pilot.

**WARNING**

**Never attempt to launch the Four Delta with the wind to your back.**

Grip the landing skid near the CG. Face into the wind and level the wing (wing parallel to the ground and nose straight ahead). Your throwing forearm should be slightly behind your ear. You want to run and toss the sUAS with the nose up at approximately 20 degrees. As you run you should feel the wing pulling up slightly. Push the wing forward with your throwing hand and release. If you are flying in a manual mode, then get on the sticks and reduce elevon trim and throttle for cruise flight.

**CAUTION**

**Check your CG before every flight.**

**Powered Flights**

It is recommended that the Four Delta be tossed with full power on.

**WARNING**

**Do not throw the Four Delta like a football. Do not twist your hand during the throw. Throw straight forward and follow through by releasing the aircraft at the top of the throw and allowing the hand to continue down in front of your body.**

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**CAUTION**

**Check your CG before every flight.**

**Landing**

The Four Delta lands much like any other aircraft. Once the aircraft transitions from base to final on the approach leg and the field is made, shut off the engines and allow the wing to settle into a nice glide. The big lifting surface of the wing does cause some ground effect and the wing will

have a tendency to float a foot off of the ground. Simply maintain attitude and allow the airspeed to bleed off. Eventually, the aircraft will slow and gently land.

Never attempt to land with a tailwind as the aircraft will just fly on and on. Crosswind landings are not a problem with practice. However, just like any other aircraft, when at all possible, land with the nose heading directly into the wind.