

# PRISM™

**WATTS**  
INNOVATIONS



**R.P.A.S.**

**FLIGHT MANUAL**

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**VERSATILITY TAKES FLIGHT**

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DECEMBER 2020

# R.P.A.S. FLIGHT MANUAL

**Category of Airworthiness:**

**Applicable Airworthiness Requirements:**

**Serial Number:**

**Registration:**

**Doc. No. :**

**Date of Issue:**

This manual must be carried with the RPAS at all times.  
Scope and revision status can be found in the Record of Revisions.

This RPAS is to be operated in compliance with the information and limitations contained herein.



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# RECORD OF REVISIONS

REVISION No.	REVISION	EFFECTIVE DATE
1	PAGES 16, 113	2/5/21
2	PAGES 4,20,26,100,114	11/3/21



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## CHAPTER 1: GENERAL

### 1.1 INTRODUCTION

Thank you for purchasing PRISM, an industrial drone by Watts Innovations, LLC.

This manual is intended to satisfy FAA and Transport Canada requirements for an Unmanned Aircraft Flight Manual as a critical part of application for advanced operations or operations below 55lbs MTOW.

### 1.2 WARNINGS AND NOTES

#### **NOTE:**

Draws the attention to any special item not directly related to safety but is important or unusual.

#### **CAUTION:**

Disregarding the following instructions leads to serious or long term deterioration of flight safety.



#### **WARNING:**

Disregarding the following instructions leads to an immediate or severe deterioration of flight safety and hazardous situations, including such resulting in personal injury or damage to property.



### 1.3 RPA GENERAL INFORMATION

<b>RPA TYPE</b>	<b>Rotary-Wing (Multirotor)</b>
<b>RPA STRUCTURE</b>	<b>Quadcopter Coaxial X8</b>
<b>RPA COMPOSITION</b>	<b>Carbon Fiber Tube Carbon Fiber Sheet Aviation-grade Aluminum Nylon PA12 Plastic</b>

PRISM is a rotorcraft that may fly as either a Quadcopter or Coaxial X8 with four or eight motors arranged in either configuration, capable of operating in a wide range of conditions for a wide range of applications.

Each motor is mounted on the end of a carbon-fiber arm at equal intervals around a flight deck using aviation-grade aluminum fastenings. The central flight deck contains the avionics between two protective carbon-fiber plates, with side-mounted data and power ports to allow sensor and battery payload integration on the top or bottom of the airframe using the integrated 12mm rail system, according to the user's needs.

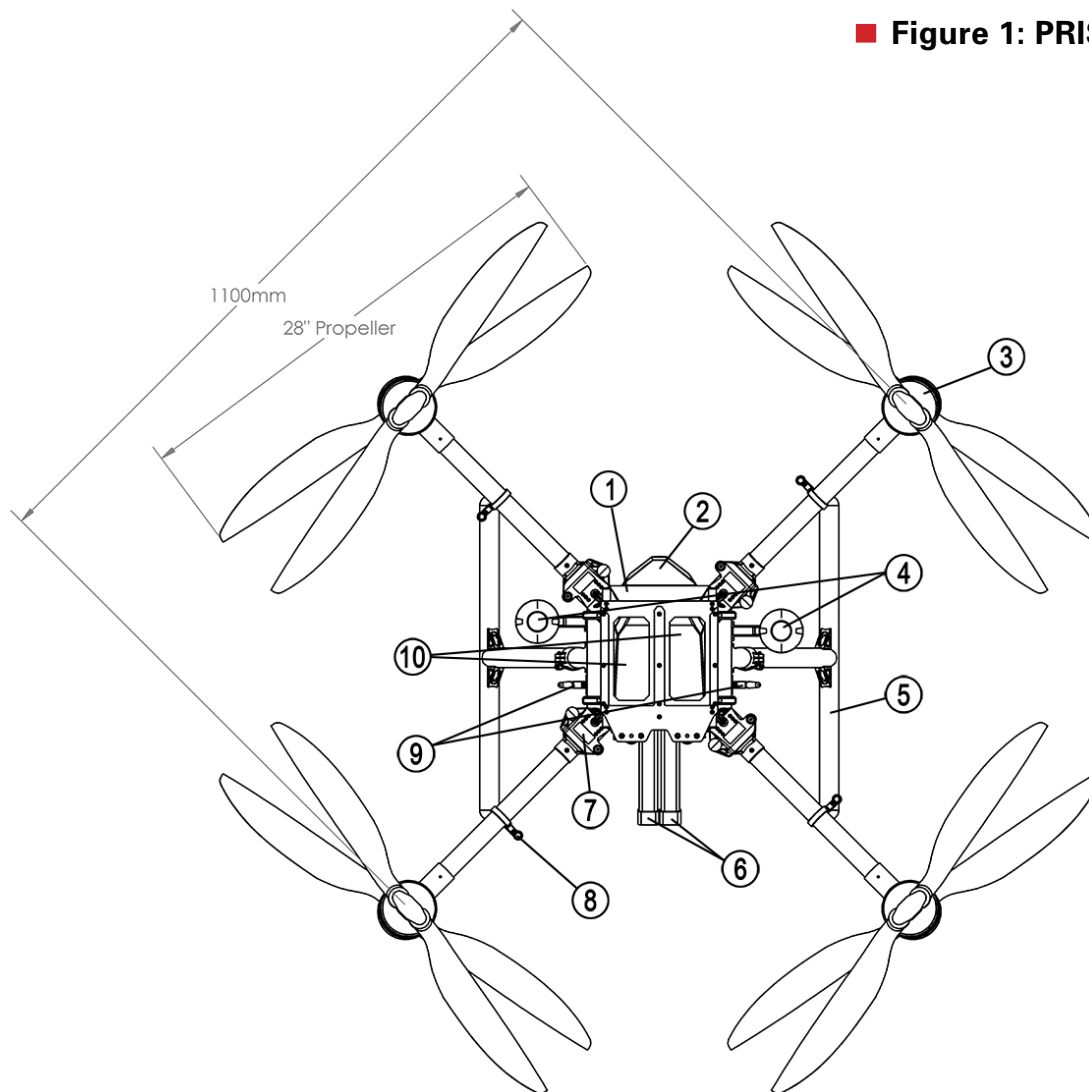
#### 1.3.1 RPA DIMENSIONS AND MASS

<b>Motor to motor diameter</b>	1100 mm
<b>Maximum Diameter</b> (Propeller tip to tip)	1817 mm
<b>Height</b>	500 mm
<b>Dry Weight</b>	15.6 lbs (7.08 Kg) (Quadcopter) 20.3 lbs (9.21 kg) (Coaxial X8)
<b>MTOW</b>	37 lbs (16.78 Kg) (Quadcopter) 59.9 lbs (34.1 kg) (Coaxial X8)



### 1.3.2 RPA DRAWINGS

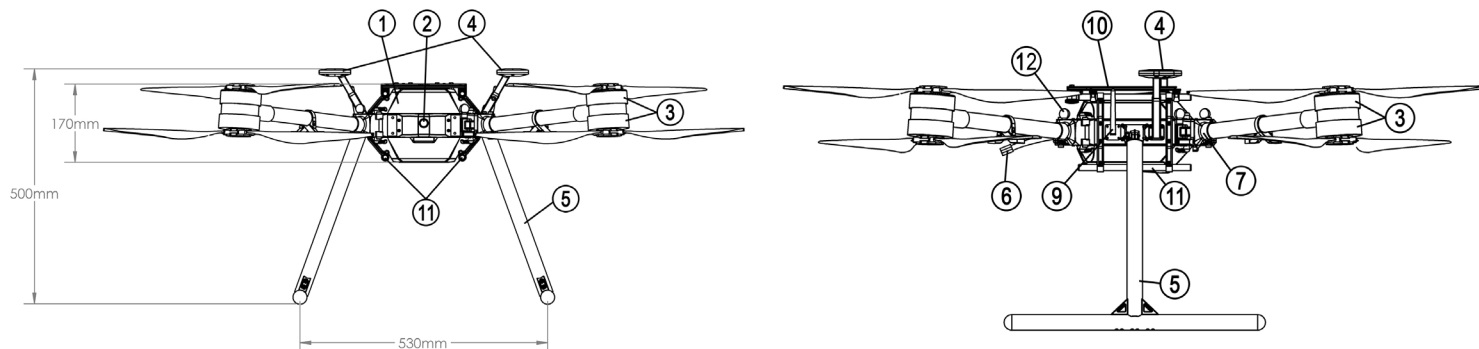
■ Figure 1: PRISM Top View



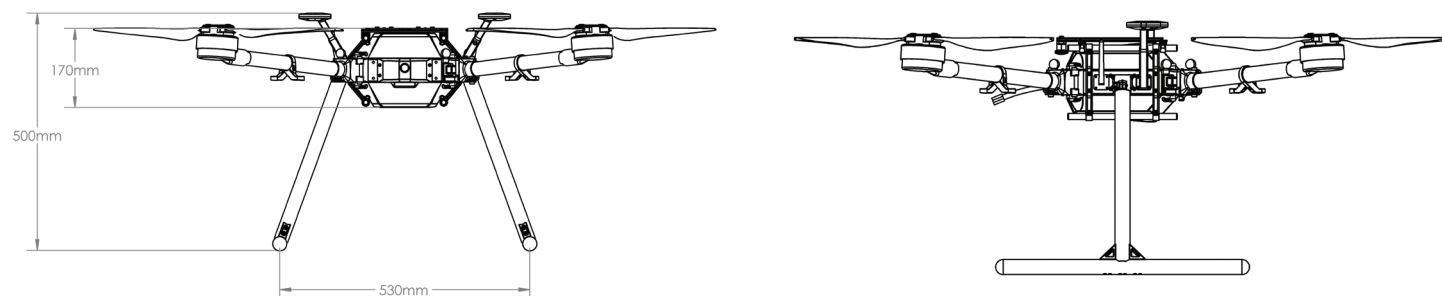
► *This figure depicts PRISM in the Coaxial X8 configuration. For three-axis views of PRISM in Quadcopter configuration, please see Supplement 1 at the end of this document.*



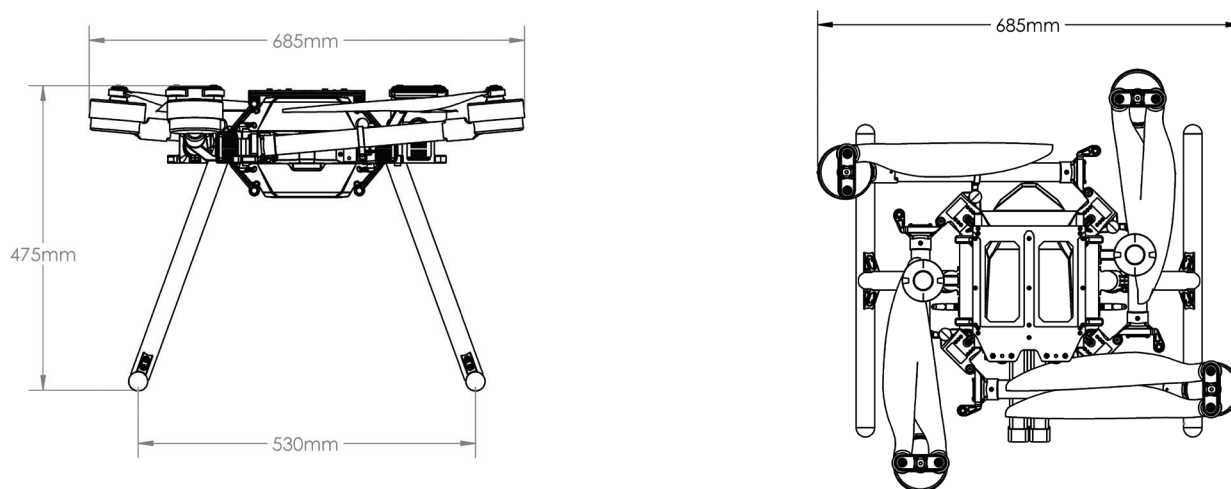
■ **Figure 2a & 3a: PRISM Coaxial X8 Front View & Side View**



■ **Figure 2b & 3b: PRISM Quad Front View & Side View**



■ **Figure 2c & 3c: PRISM Folded Front View & Top View**



■ **Table 1: COMPONENT LIST**

<ol style="list-style-type: none"> <li>1. <b>PRISM central airframe (houses the flight controller and C2 Link)</b></li> <li>2. <b>Front-facing wide-angle integrated High Definition FPV camera</b></li> <li>3. <b>T-motor U8ii motor (x2 for Coaxial)</b></li> <li>4. <b>Collapsible GPS antennas</b></li> <li>5. <b>Detaching T-bar landing gear</b></li> <li>6. <b>Aircraft power supply input ports</b></li> <li>7. <b>Watts Innovations smart propulsion system attachment assembly and folding pivot</b></li> </ol>	<ol style="list-style-type: none"> <li>8. <b>Locking hook to anchor boom when folded</b></li> <li>9. <b>Communications link antennas</b></li> <li>10. <b>Watts Innovations battery trays for 2x 12s or 4x 6S 10,000-16,000 mAh lithium-polymer batteries</b></li> <li>11. <b>12mm rail payload mounting system</b></li> <li>12. <b>Spring-loaded release knob for folding propulsion boom</b></li> </ol>
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### 1.3.3 PROPULSION SYSTEM

PRISM was created to be propulsion-system agnostic, meaning it can fly as either a quadcopter or coaxial x8, with any motor/ESC/propeller. Each propulsion system arm is user-changeable by removing only two screws. This allows users to change the propulsion configuration according to their needs. This gives users the freedom to change between a quadcopter or a coaxial x8, or replace one individual propulsion system in the event that one is damaged.

Watts Innovations intends to offer various propulsion systems for PRISM. The current offered propulsion systems are as follows:

- TMotor U8ii in a Quadcopter Configuration with folding FA28" Propellers
- TMotor U8ii in a Coaxial X8 Configuration with folding FA28" Propellers

Each propulsion system consists of a motor, propeller, ESC, carbon fiber tube, and mating bracket. Each propulsion system is hard-coded to work in only one socket location: Front Right, Front Left, Back Right or Back Left. Only the Front Right propulsion system can be inserted into the front right socket, and only the back left to the back left, etc. The user can verify that the propulsion system is inserted in the correct socket by going to PRISM menu page in the WattsQGC (See Chapter 7, section 7.11.2, subsection II).

PRISM's features a patent pending technology which is called Propulsion ID. Propulsion ID allows the user to insert any type of propulsion system that Watts Innovations produces into the aircraft, at which time the drone will automatically understand which propulsion system is connected, and then automatically load in the parameters that are necessary for flight for that particular propulsion system. In layman's terms, this allows a user



to change from a small quadcopter to a large coaxial drone in moments, with absolutely zero setup required. This also allows a user to easily service the drone himself, in the unlikely event that the drone requires a repair to one of its propulsion systems. Not only that, but this technology allows the drone to display the cumulative flight time for each individual propulsion system. Lastly, because each propulsion system's location (Front Right, Front Left, etc.) is hard-coded into the arm itself, the drone will recognize this, only allowing the user to arm if all four propulsion systems are identical and plugged into the correct arm socket.

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### 1.3.4 FLIGHT CONTROL, NAVIGATION SYSTEM, AND ONBOARD COMPUTER

PRISM uses the Pixhawk 2.1 CUBE Orange flight controller. This autopilot system is manufactured in Taiwan, and is used by thousands of RPAS around the world.

This system runs the open source ARDUOPTER Firmware, with widespread providing a proven reliability record. The flight controller employs built-in redundancy, using 3 onboard IMUs and 2 processors, limiting single point of failure of the autopilot or navigation functionality.

PRISM also utilizes dual HERE3 Compass/GPS systems which offer precise GPS location as well as an external magnetometer for direction and navigation.

In addition, PRISM utilizes a Raspberry Pi Zero-W as an onboard companion computer. This onboard computer allows PRISM to connect to a WiFi network for software updates, as well as system level configuration and control.

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*This device is FCC and CE certified, please see Supplement 4 for FCC and CE declarations.*

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### 1.3.5 COMMUNICATION SYSTEMS

This RPA is delivered with the EchoSky Mobile radio system running the proprietary WattsQGC application for flight. This link provides all required communications over a single, bi-directional, radio signal. The system comprises an air module and ground control station, and operates on the 2.4 GHz spectrum. The EchoSky Mobile system incorporates RC control, Mavlink telemetry and HD Video streaming into one compact system

This will be explored in greater detail in the following sections.



### 1.3.6 FLIGHT BATTERIES

Power for flight is best supplied by two Lithium Ion Polymer (LiPo) Battery Packs. Because PRISM may be configured with various propulsion systems, it is extremely flexible with regards to the capacity of the batteries used. PRISM is compatible with a range of battery capacities between 8,000 mAh and 16,000 mAh.

PRISM has 2x AS150U Male Connectors which accept 2x AS150U Female connectors. PRISM operates on 12s (50V). These connectors are typically used for 12s LiPo Batteries. With that, PRISM can accept:

- 2x 12s LiPo Batteries (Ranging from 8,000mAh to 16,000mAh)
- 4x 6s LiPo Batteries (Ranging from 8,000mAh to 16,000mAh)

For those who are interested in using 4x 6s LiPo packs, the optional 6s to 12s Power Plates must be used. This will put two 6s batteries in series to create 12s.



#### **WARNING:**

**Using battery-mounting solutions besides the one provided by Watts Innovations may result in the battery payload becoming unstable or detaching, and causing damage to the batteries, payload, airframe, propellers, and/or persons on the ground.**

### 1.3.7 SERIAL NUMBERS

Aircraft serial numbers are located on the outside of the front left arm socket. Each serial number is a randomly generated 7 digit number.

## 1.4 REMOTE PILOT STATION

The Remote Pilot Station acts as the interface between the PIC and the RPA. The RPS is considered part of the RPAS, and must therefore be treated with the same level of care and consideration as the aircraft itself.



### 1.4.1 ECHOSKY MOBILE RADIO

This RPS operates as a stand-alone, handheld unit providing the PIC full control of all the RPAS functions.

*This handheld unit allows manual control of the RPA via 2 joysticks and various switches, illustrated in more detail in other sections of this manual.*

*The RPS incorporates a touch screen Android device, acting as an interface between the remote pilot and the RPA.*

*The built in display provides a real-time video feed from the RPA as well as vital flight telemetry such as battery voltage, altitude and position relative to the pilot. The touch screen interface also allows the pilot to change settings on the RPA's flight control system, as well as plan and execute waypoint missions.*

■ **Figure 4: ECHOSKY RPS**



## CHAPTER 2: OPERATING LIMITATIONS

### NOTE:

All Parameters are given for operations at Sea Level and ISA. The pilot should expect a degradation of performance as operating altitude and air temperature increase. This topic is covered further in CHAPTER 5: PERFORMANCE.

<b>MAXIMUM TESTED LATERAL SPEED</b>	<b>60 mph (95 km/h, 27 m/s)</b>
<b>MAXIMUM RATE OF CLIMB</b>	<b>6m/s (19.6 m/s)</b>
<b>MAXIMUM RATE OF DESCENT</b>	<b>4 m/s (13.1 ft/s)</b>
<b>MAXIMUM BANK ANGLE</b>	<b>45 degrees</b>
<b>TURN RATE LIMITS (YAW)</b>	<b>150 degrees/second</b>

### 2.1 AIRSPEED AND FLIGHT PERFORMANCE

This Flight Controller provides the user a fully-customizable, feature-rich autopilot system. The user can set up the RPA to operate in a number of flight modes, each with different limitations. It is recommended that the user operates this RPA with the manufacturer-defined settings, in order to limit PRISM's maximum lateral and vertical velocities, ensuring safe flight at all times. The performance figures stated above were derived using the stock autopilot configuration.

### 2.2 WEIGHT

	<b>QUADCOPTER</b>	<b>COAXIAL X8</b>
<b>DRY WEIGHT</b>	15.6 lbs (7.08 kg)	20.3 lbs (9.21 kg)
<b>WEIGHT WITH BATTERIES</b>	See values scaled for battery weights, below	





Tattu 6s 8,000mAh x 4 (10.6lbs)	26.2 lbs (11.88 kg)	30.9 lbs (14.02 kg)
Tattu 6s 10,000mAh x 4 (13.75lbs)	29.4 lbs (11.29 kg)	34.1 lbs (15.47 kg)
Tattu PLUS 6s 16,000mAh x 4 (19 lbs)	34.6 lbs (15.69 kg)	39.3 lbs (17.83 kg)
Tattu PLUS 12s 16,000mAh x 2 (21.5lbs)	N/A	41.8 lbs (18.96 kg)
<b>MTOW</b>	37 lbs (16.78 kg)	54.9 lbs (24.9 kg)*
<b>MAXIMUM USER PAYLOAD</b>	See values scaled for battery weights, below	
Tattu 6s 8,000mAh x 4 (10.6lbs)	10.8 lbs (4.89 kg)	24.0 lbs (10.88 kg)
Tattu 6s 10,000mAh x 4 (13.75lbs)	7.6 lbs (3.44 kg)	20.8 lbs (9.43 kg)
Tattu PLUS 6s 16,000mAh x 4 (19 lbs)	2.4 lbs (1.08 kg)	15.6 lbs (7.07 kg)
Tattu PLUS 12s 16,000mAh x 2 (21.5lbs)	N/A	13.1 lbs (5.94 kg)

\*The PRISM X8 configuration is technically capable of an MTOW of 55 lbs or more, but may not operate at an MTOW of 55 lbs or greater by law while remaining in its weight and performance category.

## 2.3 ENDURANCE

PRISM's flight endurance varies according to payload, quantity and degree of maneuvering, and atmospheric conditions. Additionally, PRISM supports 6S lithium-polymer battery sizes from 8,000 mAh to 16,000 mAh. Using batteries of a greater capacity will logically increase flight endurance, but larger batteries also impact performance due to their larger mass.

In order to calculate flight time, the interactive Flight Time Calculator has been developed which has been derived from real-world testing. This may help users choose proper battery combinations to achieve desired flight time and operational weights. It may be found here:

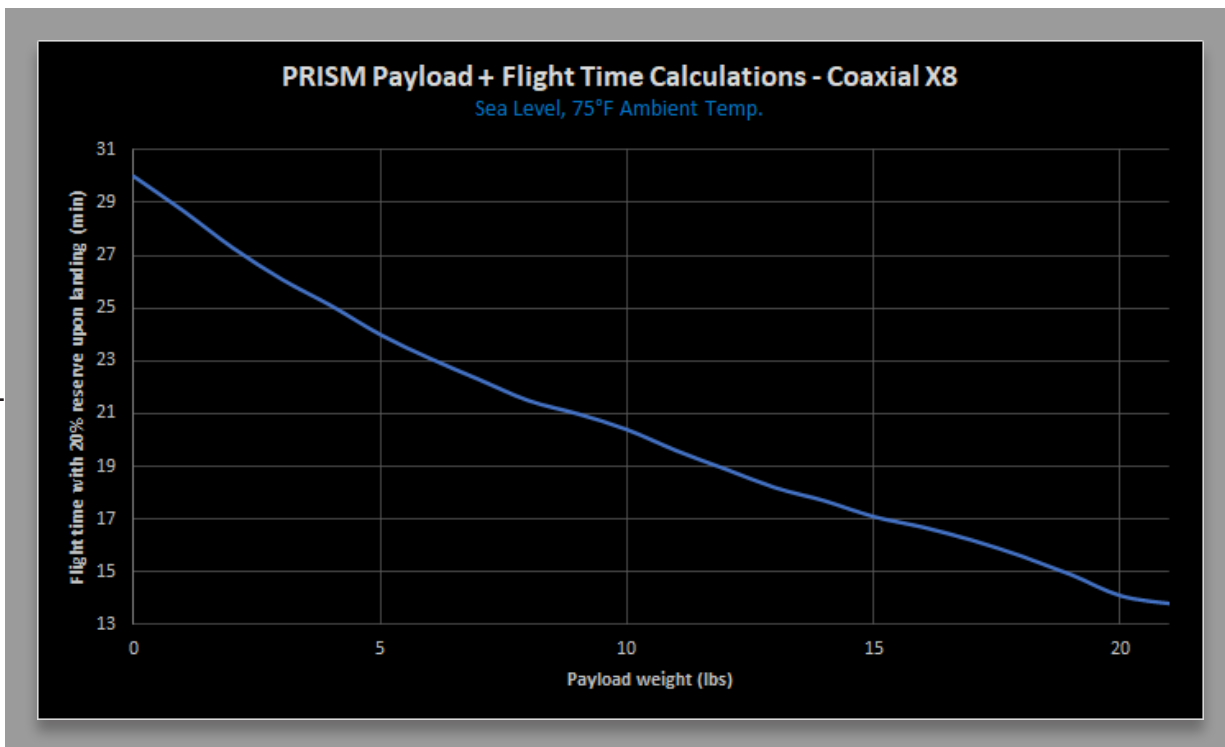
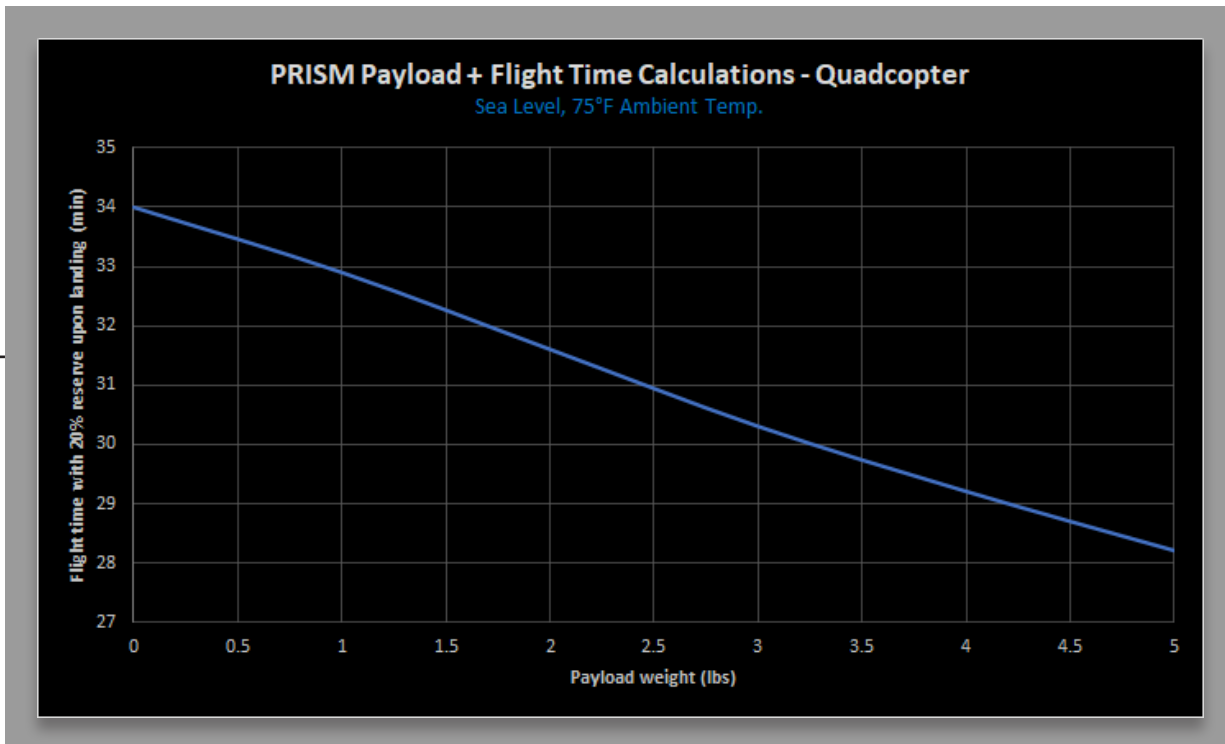
Quadcopter calculator: <https://wattsinnovations.com/pages/prismquadcalc>

Coaxial X8 calculator: <https://wattsinnovations.com/pages/prismcoaxialcalc>

**Figures 5 and 6** show graphs of the relationship between payload weight and hovering time using a pack of four x 10,000 mAh batteries (weighing 13.75 lbs) at sea level and 75°F / 24°C ambient temperature for both the Quadcopter and Coaxial X8 configurations.



■ Figures 5 & 6: PRISM PAYLOAD AND FLIGHT TIME CALCULATIONS



**NOTE:**

Operators should not discharge the batteries beyond 80% of their capacity before landing, and should not attempt to remain in the air on batteries that have less than 20% charge. Discharge levels may be monitored on the RPS display during flight. Table 2 shows the recommended usage levels per type of 6S battery in use.

**Table 2: RETURN-TO-HOME AND LANDING LEVELS FOR VARIOUS 6S BATTERY SETS**

Battery capacity (mAh)	Return-to-Home level (mAh used) – 70%	Landing level (mAh used) – 80%
8,000	5,600	6,400
10,000	7,000	8,000
16,000	11,200	12,800

## 2.4 OPERATING TEMPERATURES

Extreme temperatures will have a significant effect on the performance and safety of the RPAS operations. These effects are further discussed in CHAPTER 5.

Minimum Temperature	-10° C (14° F)
Maximum Temperature	+ 45° (113° F)

## 2.5 RADIO LINK RANGE

**ECHOSKY MOBILE:**

Control Link Range	3.1 miles / 5 km
Video Link Range	3.1 miles / 5km

**NOTE:**

The link range is affected by the RF noise floor in the area of operations. When flying in urban areas with many sources of RF radiation such as WIFI routers or Cell towers, the user should expect significant degradation of control link signal quality.



## 2.6 METEOROLOGICAL LIMITATIONS

Visual Conditions	VMC for duration of operation.
Maximum Wind Speed (measured on the ground)	10 m/s (22.4 mph, 19.4 kts)
Precipitation Tolerance	Tested to IP43 Standards



### CAUTION:

**PRISM is not built for operation in precipitation beyond a light rain or in intensely-dusty conditions.**



### CAUTION:

**The pilot must be aware that a wind speed of 10m/s as recorded on the ground may in fact be stronger as the altitude increases. The wind rating of 10m/s does not distinguish between a constant wind speed and a gust. Pilots understand that flying the aircraft in wind conditions greater than 10m/s is at their own risk.**

## 2.7 OPERATING TEMPERATURES

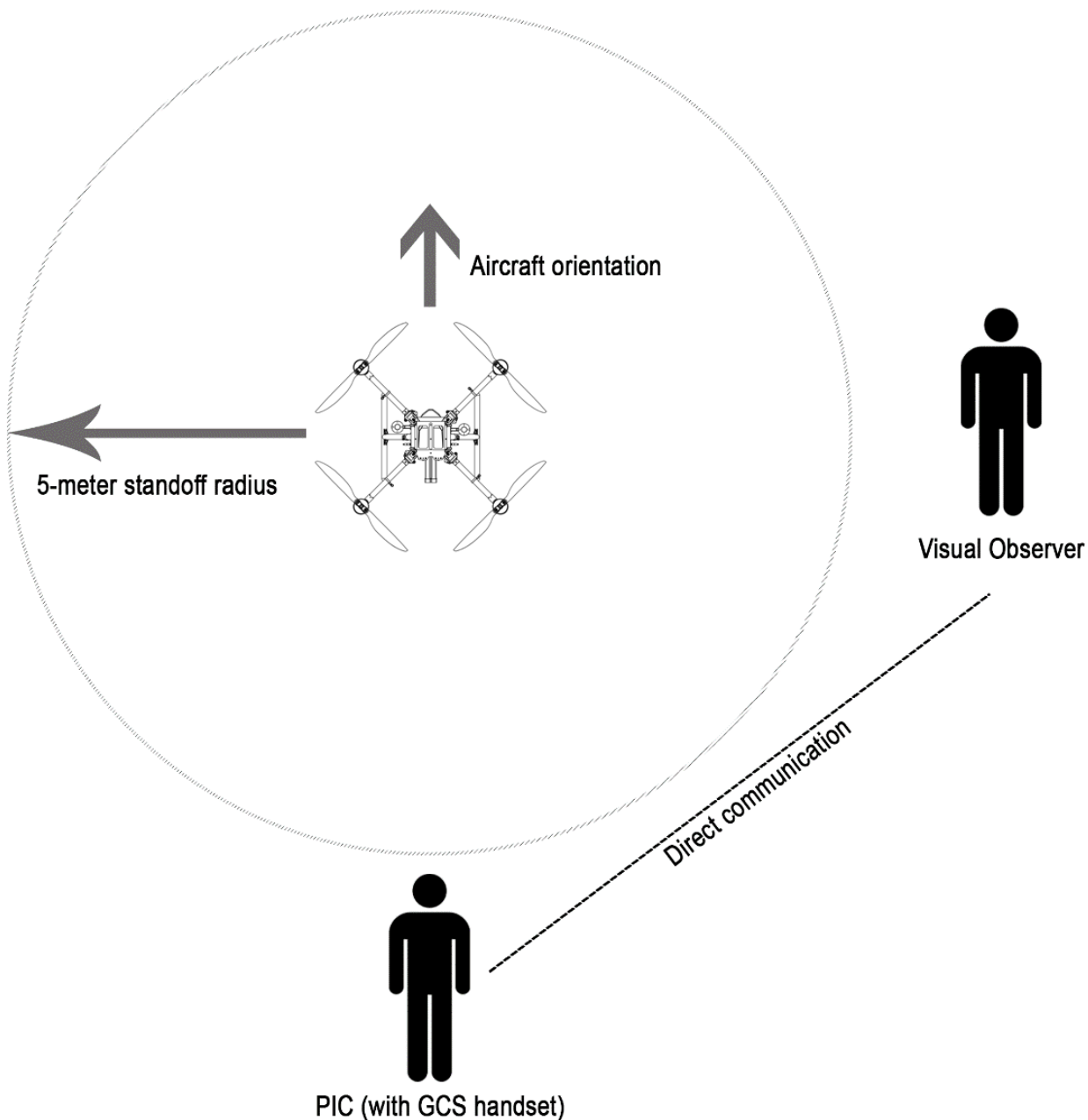
PRISM, as received from the manufacturer, should not be operated at altitudes above 3,000 meters (10,000 feet) above sea level (MSL). If High Altitude operations are required, it is highly recommended that the operator takes great care in ensuring that the aircraft is capable of performance at such altitudes. The operator may have to utilize a smaller/lighter battery system in order to gain performance at high altitudes.

## 2.8 TAKE OFF / LANDING AREA

Safe operations require a minimum of 5m radius around the RPA to be clear during take-off and landing. The cleared area should be as large as practicable to maximize the safety of the operation.



■ **Figure 7: RPA ORIENTATION DURING TAKEOFF/LANDING**



## 2.9 FLIGHT AND MANEUVER LIMITATIONS

The flight controller system limits the maximum tilt angle, speed, and motor output to ensure safe flight within operating parameters.



### **WARNING:**

**Advanced users may elect to modify the flight and maneuver limitations in the WattsQGC flight application. Damage to, or destruction of the aircraft resulting from modification of the manufacturer's default settings will not be covered under warranty, and Watts Innovations will not be held liable for damage to persons or property resulting from these modifications.**

### 2.9.1 BRAKING DISTANCE

The operator should be aware of increased braking distance required as PRISM's takeoff weight approaches the 54.9-pound maximum, and should maneuver carefully to ensure sufficient reaction time so that momentum does not carry the UAV into obstructions, persons, or property.

### 2.9.2 HIGH PAYLOAD OPERATIONS

The operator should be aware of the increased load factor present when carrying heavy payloads, and should avoid high-speed maneuvers with high tilt angles. In most cases, the UAV's flight controller will prevent PRISM from performing maneuvers which may result in a loss of lift or excessive stress to the airframe; however, users who have customized the RPA's maneuvering limits should exercise extreme caution.

### 2.9.3 HIGH PAYLOAD OPERATIONS

The operator should determine the Minimum Obstacle-Clearing Altitude (MOCA) of the operating area, and ensure that maneuvers taking place below this altitude are conducted with due caution to prevent collision.

### 2.9.4 VERTICAL DESCENT

Operators should avoid descending vertically during calm air conditions. Lowering the aircraft rapidly into its own rotor wash may result in vortex ring state, or settling with power. In this condition, the aircraft may become unstable, or lose the ability to generate



sufficient lift. Operators who detect the symptoms of settling with power should arrest the descent input and direct the aircraft to travel horizontally in a safe direction until the aircraft stabilizes. The operator may then resume descent in a spiraling downward pattern, or descend more slowly.

## 2.9.5 OPERATIONS WITHIN 30M HORIZONTALLY FROM PEOPLE

Caution must be exercised by the PIC while operating in close proximity to persons. When operating within 30m (100 ft) of a person or group of people, the PIC should adhere to the following limitations.

- Do not fly in GPS mode when there are external factors that may degrade the GPS signal strength.
- RPA ground speed must be limited to 20 km/h (12.4 mph) when operating near people.
- When operating in windy environments, RPA must not be positioned directly upwind of any persons not involved in flight operations. This becomes more relevant as the flight altitude is increased.



### **CAUTION:**

**This RPA is not certified to operate with 5m (16 ft) of any person.**



## CHAPTER 3: BATTERIES AND CHARGING

### 3.1 INTRODUCTION

This RPA is powered by TWO 8,000 mAh - 16,000 mAh 12s (50V) LiPo battery packs.. The RPA may also be powered with FOUR 8,000 mAh – 16,000 mAh 6s (25V) Lithium Polymer battery packs.

Correct use, handling and care of the battery packs are not only necessary for providing consistent, reliable power to the RPA, but also to prevent accidental fires when not in use. The Lithium chemistry used in these high performance packs can be volatile when mistreated, leading to fires or lack of power. Abuse of the battery packs will also shorten their usable life span.

### 3.2 VOLTAGE DYNAMICS

Lithium Polymer Cells provide power over a range of voltages. Typical values are 4.2 V at full charge down to 3.7 V (no load). However, during flight (under load) the individual cell voltages will drop significantly lower.

A fully charged 12 cell pack (50.4 V no load) will immediately drop to around 46 V under load. During the course of the flight the voltage will continue to drop at a shallow gradient as the charge is depleted. The rate of voltage drop will remain constant until the cells reach 3.2 V, indicating that there is very little battery capacity remaining. From this point the voltage will start to drop faster and faster as voltage “cliff” or “drop off” is reached. This situation is to be avoided as it will most likely lead to a forced landing.

It is therefore recommended that the pilot land the RPA at **no less than 43.5 V** indicated pack voltage under load. This equates to individual cell voltage of 3.7 V, and roughly 20% capacity remaining under no load. This method ensures safe operation throughout the course of the battery charge, as well as prolonging the lifespan of the battery pack itself.



#### CAUTION:

The pilot should expect and accommodate for a drop in performance during high power maneuvers as the battery pack nears the end of its discharge cycle. It is also to be expected that the voltage will drop noticeably during high power maneuvers, but will bounce back when the RPA returns to a hover.





**CAUTION:**

Cold temperatures below 10° C will negatively impact the performance and endurance of the flight. The pilot must be aware and compensate during flight planning.

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### 3.3 STORAGE AND TRANSPORT

When not in use, the batteries should be stored in a fireproof aluminum battery case. This will protect the packs from damage while not in use. Any puncture to the battery cells will result in permanent damage to the cell and could cause a fire.

Batteries should be kept in a cool, dry place that will contain the smoke and flames in case of a fire. A fire extinguisher must be on hand during storage, transport and charging. Batteries should be kept at storage voltage of 3.85V (23V pack total) when not being used for more than a week. This will prolong the life of the packs as well as making them less volatile.

- Keep LiPo battery packs WELL out of reach of children.
- Do not put battery packs in pockets or bags where they can short circuit.
- Do not store or transport or store batteries where they can come into contact with sharp or metallic objects.
- Do not store your LiPo pack in extreme temperatures below 0C or above 50C.
- Always store your LiPo pack in a safe and non flammable container away from flammable objects. A LiPo Sack or metal / ceramic storage container is best.
- Always store your LiPo Batteries partially charged. They will maintain their performance levels over time and there's no need to cycle them unless stored for periods longer than 3-6 months.

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### 3.4 BATTERY CHARGING

The Following guidelines should be followed at all times when handling and charging LIPO batteries

- Always charge LiPo batteries on fireproof surfaces such as cement, steel, ceramic or stone.
- Do not leave a LiPo battery fully charger for more than 3 days (72 Hours)
- Do not charge batteries near flammable products or liquids.
- LiPo batteries should be charged within a temperature range of 0C to 30C.
- Never leave a charging lithium polymer battery pack unattended.
- Do not charge inside an automobile, especially while driving.
- Do not store batteries inside an automobile.



- Do not charge a lithium polymer battery pack at a rate over 1C.
- Never charge a LiPo pack that has ballooned or swelled due to over / under charging or from a crash.
- Never charge a lithium polymer battery pack that has been punctured or damaged in a crash.
- Have a fire extinguisher near the charging area or a large bucket of dry sand. Do not try to extinguish with water. Use a Class D fire extinguisher.
- If you notice your LiPo battery pack is swelling, stop the charging process immediately, put the battery in a safe container and observe it for 15 minutes.

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### **3.5 DECOMMISSIONING AND DISCARDING OF BATTERIES**

Once a Battery has undergone more than 200 cycles, it should be decommissioned and cannot be used for flight operations. A battery may be decommissioned before it reaches 200 cycles if it becomes swollen, damaged or has high internal resistance measurements.

Because of the potentially hazardous battery chemistry, LIPO batteries need to be discarded in a proper manner to avoid fires. The first step is to remove all charge from the cells. This can be done by submerging the battery in salt water solution. Current will slowly flow between the battery terminals and the battery will end up with zero voltage. This method protects against any combustion as the battery is under water.

Once the Battery is completely discharged it can be discarded at a municipal dump or scrap yard.



## CHAPTER 4: NORMAL OPERATING PROCEDURES

### 4.1 PREFLIGHT

Prior to commencement of Flight Operations for the day, PIC to inspect aircraft as per the Preflight Checklist below:



## PRE FLIGHT CHECKLIST

### 1. AIR FRAME

- Inspect all arms are securely latched to the center frame with each spring-loaded mechanism locked in place.
- Verify no play movement between boom and folding mechanism.
- Inspect center airframe for structural anomalies.
- Inspect the airframe for potential loose parts or missing fasteners.
- Inspect FPV camera to verify it is secure and the lens is clear.

### 2. BOOMS

- Inspect the length of each boom for any damage or wear to the carbon fiber tube, paying close attention to the junctions on either end.
- Check PRISM aircraft status page in WattsQGC to ensure the propulsion booms are correctly mounted and showing a green status indicator.



### 3. MOTOR MOUNTS

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- Inspect for play between each motor mount and boom.
- Inspect for any sign of wear or damage of aluminum components.
- Ensure the heat sinks for the ESCs are clear of debris.

### 4. MOTOR

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- Inspect for play between motor bell and base.
- Spin the motor by hand and inspect for rough or constricted rotation.
- Inspect motor bell for any dents or scratches indicating prior impact.

### 5. PROPELLER

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- Inspect each propeller blade to ensure it is correctly fastened to propeller hub.
- Inspect for pitch play between propeller and hub.
- Inspect propeller for wear, damage or warping.
- Gently flex propellers to check for microfractures, especially near the hub or mounting point.
- With propellers unfolded, verify the blades remain clear of adjacent structures and propellers as they rotate through a full motion.



## 6. BATTERIES

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- Test the voltage of each battery pack; log readings.
- Inspect each battery for any signs of damage or swelling.
- Inspect battery connectors and leads for damage or wear.
- Ensure all batteries are securely fastened to the battery tray.
- Ensure battery plate is securely fastened to airframe with both locking pins fully seated.
- If using a battery with a long wire harness, ensure that the remaining slack is bundled with the supplied Velcro strap to ensure it does not make contact with the rear propellers.

***Pull firmly on the battery to physically ensure the locking pins are engaged!***

## 7. LANDING GEAR

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- Verify the gear are securely fastened to airframe (or payload, if operating with a configuration where the payload replaces the stock landing gear).
- Verify no damage to carbon tube structure.
- Verify correct orientation of landing gear legs.

## 8. ANTENNAS

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- Verify GPS antennas are locked in their extended position.
- Verify control link antennas are securely fastened and correctly oriented.
- Inspect FPV antenna secured in correct orientation (If applicable).



## 9. LIGHTING

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- Verify RPA navigation lights on the end of each boom are functional.
- Verify Strobe light is operating (if applicable).

## 10. PAYLOAD ATTACHMENT

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- Inspect payload attachment points and ensure anti-drop clip is in place (if used).
- Quick release system locked (if applicable).
- Payload correctly oriented.
- Check payload data and power connections.

## 11. REMOTE PILOT STATION

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- Verify antennas are in good condition and correctly oriented.
- Inspect free movement of control sticks. Check for dust or debris.
- Calibrate control sticks and inputs if necessary.
- Check the RPS battery levels are sufficient for the duration of operation.

## 12. FAILSAFE SETTING

---

- Check that the RPA Failsafe is appropriately set for type of operation and environment.



## 4.2 POWER UP

1. Power up payload and ensure it is functioning correctly
2. Power on the ground control station. This is done by pressing the power button one time, releasing, then pressing and holding for longer than 3 seconds.
3. Connect each battery plug to the corresponding plug on the aircraft. Avoid moving the aircraft while the system initializes. A series of tones or beeps during this time is normal. Verify that the Autopilot has booted correctly, which will be indicated on the WattsQGC application.
4. Open the WattsQGC application. As the application loads, a green progress bar will progress from left to right. This shows the status of the Mavlink parameters which are being loaded from the aircraft. In addition, the video display on the EchoSky handset will show once all parameters have been loaded. Avoid changing the aircraft, sensor, or payload configuration while the app is pulling in parameters.
5. Verify no errors in the overall system status, indicated on the GCS telemetry feed. Errors could include excessive RF noise, magnetic interference, GPS signal strength, IMU health, and video downlink integrity
6. Verify the RTL failsafe altitude and ensure that the aircraft will clear any obstacles in the operating area during an automatic RTL failsafe recovery by calculating the MOCA.
7. Ensure the Low Voltage RTL warnings are set for your particular application, flight envelope and payload.

## 4.3 FINAL CHECKS BEFORE TAKE OFF

1. Observe the RPA is has acquired GPS lock.
2. Verify sufficient RPAS battery voltages.
3. Observe the wind conditions have not changed significantly and are still within operational limits.
4. Observe VMC for the intended area of operation.
5. Verify the launch area / pad is level, totally clear and secure.
6. Position RPA nose into wind, PIC standing behind RPA.

## 4.4 ARM AIRCRAFT AND TAKE OFF

1. Select either ALTHOLD or POSHOLD flight mode with the three position switch on the left side of the aircraft. Complete the pre-flight checklist in the WattsQGC application to enable system arming.
2. Arm the RPA using the button on the WattsQGC interface and then sliding to confirm, or by using the left stick on the RPS (Throttle stick DOWN, yaw to the RIGHT). The WattsQGC application will audibly announce "Armed" when the vehicle is indeed armed.



**WARNING:**

If arming PRISM using the app while in STABILIZE mode, ensure the throttle (left stick) is pulled all the way down before confirming. Failing to hold the throttle down will cause the aircraft to leap into the air once armed.

3. Observe all motors spool up correctly.
4. Apply power to lift off and ascend quickly out of ground effect (1-2 meters).
5. Confirm RPA is stable and reacting correctly to stick inputs.
6. Enter POSHOLD mode and confirm the RPA holding its current position.
7. Observe battery voltage has not dropped significantly under load.
8. Verify RPAS ready to commence flight operations.

---

## 4.5 FLIGHT

1. Check battery voltage on the display at regular intervals.
2. Ensure both video telemetry & control link signal strengths are within acceptable levels.
3. Ensure RPA is within predetermined flight boundaries.
4. Be aware of any meteorological changes during the flight.
5. Be aware of any manned/unmanned aircraft entering the operations area.
6. Ensure sufficient battery capacity remaining to return safely to base.

---

## 4.6 DESCENT AND LANDING

1. Ensure landing area is clear of all persons, debris, and equipment.
2. Payload operator to prepare payload for landing.
3. Command a steady, angled flight path towards the landing area; avoid descending vertically through RPA downdraft.
4. Bring the RPA to a hover roughly 15 ft (3 m) above landing area.
5. Slowly lower RPA to touch down, ensuring minimal horizontal movement after landing gear has made contact to avoid dynamic rollover.
6. Disarm RPA (Throttle stick DOWN, yaw to the LEFT). The WattsQGC application will audibly announce "Disarmed" when the vehicle is indeed disarmed.
7. Observe all propellers stationary before approaching.

**NOTE:**

Aircraft will automatically disarm after 15 seconds

---

## 4.7 SHUT DOWN

1. Power down RPA by disconnecting the battery plugs.
2. Remove the battery tray from RPA. Aircraft is now "safe".
3. Power down RPS.
4. Power down Payload.





## 4.8 AFTER EACH FLIGHT

1. Inspect each motor for excessive heat buildup.
2. Inspect each propeller for damage or play.
3. Inspect each boom for flex, displacement, or play.
4. Inspect each battery for excessive heat or swelling.
5. Log the flight time and observations.

## 4.9 AFTER ALL FLIGHT OPERATIONS COMPLETED

After flight operations conclude for the day, perform post-flight inspection as per Checklist below:



## POST FLIGHT CHECKLIST

### 1. AIR FRAME

- Inspect all arms are securely latched to the center frame with each spring-loaded mechanism is locked in place.
- Verify play movement between boom and folding mechanism.
- Inspect center airframe for structural anomalies or excessive heat.
- Inspect the airframe for potential loose parts or missing fasteners.
- Ensure FPV camera is secure and the lens clear.

### 2. BOOMS

- Inspect the length of each boom for any damage or wear to the carbon fiber tube, paying close attention to the junctions on either end.



### 3. MOTOR MOUNTS

- Inspect for play between each motor mount and boom.
- Inspect for any sign of wear or damage of aluminum components.
- Ensure the heat sinks for the ESCs are clear of debris.

### 4. MOTOR

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- Inspect for play between motor bell and base.
- Spin each motor by hand and inspect for rough or constricted rotation.
- Inspect motor bell for any dents or scratches indicating impact.

### 5. LANDING GEAR

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- Ensure the gear is still securely fastened to either airframe or payload.
- Ensure no damage to carbon tube structure.

### 6. ANTENNAS

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- GPS antennas securely fastened and positioned for storage.
- Control link antennas are securely fastened and folded into their storage position.
- Inspect FPV antenna secured in storage orientation (if applicable).



## CHAPTER 5: PERFORMANCE

### 5.1 INTRODUCTION

This RPA has been designed to operate well within the limits of each component and subsystem. This provides a large safety factor while operating under almost all conditions.

For example, the maximum combined thrust of the RPA propulsion system in Quadcopter configuration is 64 lbs (29.2 kg) (at sea level), while the MTOW in that configuration is specified as 37 lbs (16.78 kg). This excess power provides large headroom for stability control and operating in emergency situations. It also means that during normal operation the propulsion system is not being strained and is able to operate efficiently.

External factors that will affect the performance are dealt with in the following sections.

### 5.2 ALTITUDE

The altitude of flight operations above sea level has the greatest effect on the performance and endurance of the RPA. Because flight operations in most of North America are limited by law to 120m (400ft) above ground level, no change in performance is expected during any particular flight. The effect will only need to be taken into account when flying from different geographical locations, at different elevations above sea level.

When operating at significant altitude above sea level, the pilot should expect a loss in both thrust and flight endurance. This is due to the thinner air causing the motors to spin faster to produce the same amount of thrust. The motors will therefore be operating closer to the maximum RPM, reducing the headroom available and the efficiency of the propulsion system. While this effect may be offset by using propellers with a camber adjusted for high-altitude operations, even high-altitude props will not guarantee normal operations at or above the listed operating ceiling.

### 5.3 TEMPERATURE

As well as affecting density altitude and flight performance of the aircraft, air temperature also affects systems and components onboard the RPA. These effects can be compounded to create a significant overall performance drop. The pilot must adhere to the operating temperature limitations of between -10° C and +45° C in order to ensure safe flight operations.



If operating in excessively HOT conditions (90F/ 32C and above), it is recommended that the pilot:

- Keep the aircraft in a shaded area when not in flight. Do not allow the drone to be exposed to direct sunlight when not in use**
- Keep the flight batteries in a shaded area when not in flight. Ensure that the batteries are not exposed to direct sunlight while charging.**

If operating in excessively COLD conditions (40F/ 4C and below), it is recommended that the pilot:

- Plug in the aircraft and allow the autopilot to warm up to proper operating temperature. The Cube flight controller offers a heated IMU, which when powered up will attempt to bring the IMU up to proper operating temperature. It is recommended that pilots allow the autopilot to warm up for at least 5 minutes before flying if the aircraft has been sitting in cold temperatures.**
- Keep the batteries in a warm environment when not in flight. It may be useful to keep these in a vehicle when not in use or while charging.**

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### 5.3.1 AIR DENSITY (DENSITY ALTITUDE)

Increased air temperatures affect the density of the air in which the RPA operates. Similar to an increase in altitude above sea level, higher temperatures create a lower air density. Operating in this "thinner" air reduces the power available and requires faster propeller RPMs for the same amount of thrust at a lower temperature. This has a negative effect on the endurance of the RPA, and when compounded with the loss of motor efficiency can result in noticeably less flight time.

Flight operations are to be carried after taking into account the current density altitude (a function of air temperature and elevation) of the flight operations area.

---

### 5.3.2 BATTERIES

Lithium Polymer chemistry is affected by the ambient temperature. This effect is most noted in cold conditions (Below 10° C) when the rate of chemical reaction is slowed and the cells' ability to supply power is diminished. This means less instantaneous power delivered to the RPA (Lower discharge rating) as well as less overall capacity available (Less endurance). Storing the battery packs in a warm place until immediately before use will minimize the loss of performance.



Operating in hot environments (above 35° C) will place increased strain of the chemistry of the battery packs. As the packs are discharged during flight, they generate heat internally.

This heat generation increases as the voltage drops towards the end of the discharge cycle when more current is required to supply the required power to the RPA.

Excessive heat can cause the cells to swell and can permanently damage the internal chemistry, decreasing the pack's usable life span. It also increases the waiting period while the pack cools before it can be recharged. For these reasons the pilot should be aware of not flying the packs down to the limit or performing power intensive maneuvers while operating in hot conditions.

---

### 5.3.3 PROPULSION SYSTEM

The efficiency of the motors is affected by high temperature operations. As current is passed through the motor coils they generate the electromagnetic force that drives the propeller. This current also heats the coils and increases their resistance to the current being pushed through the coils.

This greater resistance increases electrical power losses in the propulsion system, decreasing the overall efficiency. For this reason the RPA propulsion system is designed to operate well below the maximum power capacity, keeping the motors cool and maximizing efficiency. When the ambient temperature increases significantly, the motor temperature will rise as a direct result and a loss of flight endurance is to be expected.

The brushless motor system also dumps excess heat through the heat sinks on the electronic speed controllers (ESCs). In excessive ambient temperature, the heat sinks cannot exchange thermal energy efficiently, which can cause heat to build up in the ESCs to the point of failure.



## CHAPTER 6: MASS AND BALANCE

### 6.1 INTRODUCTION

This multirotor RPA can operate safely through a wide range of All Up Weights. The AUW will have a significant impact on endurance and handling. These effects are described in detail in other sections of this manual.

### 6.2 RPA MASS

**Table 8: RPA MASS**

	Quadcopter	Coaxial X8
<b>Dry Weight</b>	15.6 lbs (7.08 kg)	20.3 lbs (9.21 kg)
<b>MTOW</b>	37 lbs (16.78 kg)	54.9 lbs (24.9 kg)
<b>Maximum Payload</b> (w/ 4x 10,000mAh batteries)	7.6 lbs (3.44 kg)	20.8 lbs (9.43 kg)

### 6.3 BALANCE

The payload attachment point is directly above or below the center of thrust of the aircraft, depending on user configuration. The RPA airframe itself is likewise balanced about the center of thrust.

Many payloads designed for flight on RPAs are balanced about their points of connection with the airframe. This leads to the ideal situation in which the entire RPA and payload is balanced about the center of thrust. Each motor therefore will draw an equal load during hover, leading to the most efficient and safe flight.

This RPA, however, can operate with a range of generic payloads that may not be balanced about their respective attachment points.

PIC must note the amount of imbalance in the system prior to flight. If the RPA is significantly imbalanced, alternative payload solutions should be sought out.



#### **CAUTION:**

**Payloads should only be attached to the designated attachment point(s). Attaching a payload to any other part of the aircraft may cause severe imbalance or impact the structural integrity of the airframe, or introduce destructive vibration.**



## CHAPTER 7: RPAS DESCRIPTION

### 7.1 INTRODUCTION

This section provides further information about each of the subsystems incorporated in PRISM RPAS. The functionality and operation of each sub system is detailed in the following sections.

More information about the maintenance of each subsystem is provided in **Chapter 10**.

### 7.2 AIRFRAME

The Airframe consists of a central, octagonal body that houses the flight control system, communication systems and power systems. Each of the 4 boom arms are connected to a corner of the body via a folding/locking mechanism that allows the booms to fold sideways against the central body for transport and storage. The booms are locked into position during flight with a spring loaded pin system.

The Central body is constructed from flat carbon fiber sheets, affixed to each other with several vertical aluminum bulkheads. This creates the rigidity in the body required to safely handle forces and loads experienced during flight.

PRISM features a sturdy 12mm carbon fiber rail system which is securely mounted to both the top and bottom of the aircraft. This 12mm rail system may be used for mounting battery tray(s), payloads and other accessories.

The Flight Battery Tray attaches to the top or bottom of the airframe, sliding into position where it is secured onto the 12mm rail system. A total of four bolts must be tightened in order to ensure the battery tray is securely attached to the 12mm rail system.

### 7.3 LANDING GEAR

PRISM uses T-shaped landing gear constructed from carbon-fiber rods that attach firmly into receptacles built into the underside of the central airframe. These have been constructed to provide adequate ground clearance for mounting a range of payloads beneath the airframe without adding significant weight to the MTOW. These landing gear are 30mm in diameter and when installed, offer a ground clearance of 12". If a higher ground clearance is required, please contact Watts Innovations support to request a longer landing gear set.

PRISM can be configured to operate with payloads which may use alternate landing gear. When using these payloads, the PIC must account for deviations from the manufacturer-defined weights and balances.



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## 7.4 FLIGHT CONTROL SYSTEM

This chapter deals with the primary functions of the flight control system. The open source **ARDUCOPTER** firmware provides a fully customizable, feature rich autopilot system for PRISM. The flight controller has been pre-configured by WATTS INNOVATIONS to enable the operator to complete most tasks in a safe and efficient manner. A more in depth study of the autopilot system and features may be conducted using the online resources at <https://ardupilot.org/copter>

It is important to note however, that PRISM utilizes a custom Arducopter firmware. This means that it should not be updated to a standard Arducopter firmware, as this will break all of the intuitive features found within PRISM. **Updating to a stock Arducopter firmware will void your warranty.**

Guidance, navigation, and control are provided by Pixhawk CUBE flight controller system. Sensors in the CUBE include a triple-redundant, 6-axis inertial measurement system; GPS/GNSS receiver and magnetometer (compass); and dual barometric pressure sensors for detecting aircraft altitude.

This system allows for operation in **5 primary flight modes**, and multiple **Failsafe modes**. The pilot can change flight modes with the three-position FLIGHT MODE switch on the remote control unit, and the mode of each position may be defined in the WattsQGC app. When operating through the mobile device interface, the pilot will have the ability to select from a variety of other flight modes as required.

This manual deals with the 5 primary modes that can be selected using the handheld radio control unit only. Each mode is discussed in turn as follows.

It should also be noted that the user may choose to use STABILIZE flight mode, which is a self leveling mode (for both the roll and pitch axis), where the throttle is a direct correlation to the % of throttle given by the user. Pilots must be extremely careful when arming and taking off in STABILIZE mode. In addition, the RPA may either “jump” or “drop” up to 3m when transitioning from STABILIZE to ALTHOLD mode. Flight in STABILIZE mode is not recommended but can be useful in the hands of a skilled pilot.

---

### 7.4.1 ALTITUDE HOLD

ALT HOLD mode is the base flight mode of this PRA, and provides the most manual control over the aircraft. In this flight mode, the aircraft uses the onboard sensors to only stabilize its attitude and altitude.

Pitch and roll are commanded by manipulating the respective control sticks.





At neutral control input (center pitch and roll stick position) the RPA will remain level and not increase or decrease altitude. See Caution below.

Altitude rate of change is controlled by the amount of deviation from center point of the throttle stick. The higher the throttle stick position, the faster the climb. Conversely, the lower the throttle stick position, the faster the RPA will descend.

**CAUTION:**

**This flight mode does not provide any lateral positional control of the RPA. PIC must be aware that the RPA will drift if any wind.**

---

**7.4.2 POSITION HOLD**

This flight mode uses GPS inputs to maintain position during flight. Pilot inputs via the pitch/roll sticks command changes in ground speed. Pitch and roll stick deflection will command fore/aft and left/right ground speeds respectively. Controlling altitude in POSHOLD mode is the same as in ALTHOLD. With pitch and roll controls centered, the RPA will attempt to hold its current position and altitude. The aircraft will self-correct for disturbances that may force it from the desired position.

**CAUTION:**

**This mode requires a strong GPS signal and communication with a minimum of 6 satellites. Although the GPS system functions without issue most of the time, it is still vulnerable to interference from outside elements.**

**This interference may be caused by multipath error, solar storms, operation in close proximity to powerful radio transmitters or operations within urban canyons.**

**If a weak signal is present, the RPA will not enter POSHOLD Mode. If the GPS signal degrades while in POSHOLD Mode, the aircraft will automatically revert to ALTHOLD Mode.**

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**7.4.3 AUTO MODE**

Auto mode instructs the RPA to follow the waypoint mission plan uploaded to the autopilot system. The pilot will only have manual control of the RPA heading while the mission is being carried out. The autonomous mission can be paused at any time by toggling the flight mode switch on the RPS. To exit AUTO mode, the user can simply flip the switch into either ALTHOLD or POSHOLD.

**CAUTION:**

**Although the mission can initiate an automatic take off and landing, it is highly recommended that the PIC perform a manual take off and landing.**



#### 7.4.4 RTL MODE (RETURN TO LAND)

This mode can be selected in an emergency situation, and will command the aircraft to automatically return to home and land. The home position is recorded automatically when the aircraft is armed and the aircraft will return to this exact original takeoff position. For this reason, ensure that the drone may safely be landed in extreme circumstances, especially operating from a moving platform (such as a truck, boat, etc).

As part of the preflight planning, the pilot should identify the height of all tall objects in the flight operations area. The RTL ALTITUDE should be set to a height that is greater than that of the tallest object with a comfortable margin of error (10-20%). This is done to ensure that the aircraft can always maintain separation from all objects while autonomously returning to land. This is set in the SAFETY menu of WattsQGC.

Once the RPA has arrived above the home position, it will automatically descend and perform a landing. This situation is described in detail in the Emergency Procedures section.

The RTL altitude and behaviour can be set via the GCS prior to flight.



#### CAUTION:

**When operating from a moving vehicle, the pilot must be aware that "Home" position is recorded where the RPA first took off. This may be distant from the position of the pilot when the RTL is commanded. The aircraft will not return to the pilot.**

#### 7.4.5 FAILSAFE MODES

This Autopilot system makes provision for a number of failsafe conditions and corresponding actions. These failsafe triggers and responses are fully customizable, although it is recommended not to alter the factory settings unless absolutely necessary.

##### (i) Radio Control Link Loss (RADIO FAILSAFE)

In the event of a sustained loss of the C2 link between the RPS and the aircraft, the RPA will enter **Radio Failsafe Mode**. This mode enacts a preconfigured action in the emergency situation. Prior to flight operations, the PIC should determine the most suitable failsafe action, depending on the operating environment and nature of flight.

The failsafe settings are configured in the WattsQGC application.

The default configuration is to automatically enter **RTL MODE**.



### (ii) Ground Control Station Link Loss (GCS FAILSAFE)

This mode is relevant during missions in AUTO mode, where the Pilot is not controlling the RPA manually via the radio control. It may be the case that the RPA is operating beyond the range of the Radio Control link.

In the event of a sustained loss of the Ground Control Station link between the RPS and the aircraft, the RPA can be set up to perform two actions: The aircraft can be set to RTL regardless of flight mode (the default setting); or it can continue the mission in AUTO mode even while the C2 link is lost.

The failsafe settings are configured in the WattsQGC application. By default, the GCS Failsafe is not enabled, as the RPA has dual communication with the GCS (either by Radio or by Datalink). Only the loss of RC Control will initiate a RTL. For example, if the pilot exits WattsQGC during flight, the aircraft will not initiate a RTL. However, if the pilot turns off the EchoSky Mobile handset while in flight, this will initiate a RTL, as the RC radio itself has been turned off.



#### **CAUTION:**

**It may be the case that while executing an AUTO mission, the RPA is beyond the range of both video and control communication links. The Pilot will not receive telemetry information or be able to control the RPA. This situation should be avoided by comprehensive mission planning, taking into account control link range and LOS conditions.**

### (iii) Battery Failsafe

If the battery voltage drops below the Low Voltage Threshold, the RPA will enter low battery Failsafe mode. This is indicated by a Yellow Flashing Status LED and on the GCS monitor. The RPA will enter **RTL mode** and begin to return back home. The pilot is to terminate the flight and land as soon as possible, as the battery failsafe does not factor in travel time to the home location.

The second level of battery failsafe is invoked when the voltage drops below the CRITICAL VOLTAGE threshold. In this case, the RPA will enter **LAND mode** and begin an automated descent in place. This mode is a last resort to prevent total battery depletion while in the air. The LED will turn Flash red and Critical Battery Voltage will be displayed on the GCS.

Low battery Failsafe procedures are described in more detail in **Chapter 8: Emergency Procedures.**



#### **WARNING:**

**Low Battery is the leading cause of RPAS incidents. The Pilot should never let the battery voltage drop to either of the battery failsafe thresholds during normal operations. Flights should be planned to land before Battery Failsafe is invoked.**



## 7.5 PROPULSION SYSTEM

PRISM maneuvers by means of variable propulsion through its four to eight U8ii motors. Each motor is equipped with a 28-inch folding propeller, and motors are arranged in alternating clockwise (CW) and counter-clockwise (CCW) configuration to cancel rotational inertia and provide the maximum-possible stability in flight.

The T-Motor U8ii motor system operates on a 48-volt power supply to provide a maximum thrust of 7.3 kg (16 pounds) per rotor at sea level, for a combined thrust of 29.2 kg (64.4 pounds) in the quadcopter configuration, or approximately 58.4 kg (128.7 pounds) in the coaxial X8 configuration (this value is approximate due to the reduced efficiency of thrust when motors are paired in a coaxial configuration). The X-Carbon polymer (quadcopter) or T-motor P&G Series carbon-fiber (coaxial X8) fixed-pitch propellers are 28 inches from tip to tip when unfolded.

Propellers are mounted to the T-motor U8ii motors, a pancake-style electronic brushless designed for efficiency and intelligence. Each motor weighs 200 grams (7.1 ounces) and has a KV of 85 RPM per volt.

### 7.5.1 WATTS INNOVATIONS PROPULSION-AGNOSTIC SYSTEM (PROPULSION ID)

The Watts Innovations PRISM's unique propulsion design allows users to fly the aircraft in either a quadcopter configuration, or in an Coaxial X8 configuration with two motors mounted coaxially to each boom.

PRISM is shipped with a propulsion system that is determined by the user (generally either a Quadcopter or Coaxial X8). Each is hard-coded and tuned for optimal performance at a specific mounting location about the central airframe: Front Right, Front Left, Back Right and Back Left. The mounting locations cannot be interchanged, and incorrectly-mounted propulsion booms will cause the flight controller to fail a pre-arm systems check.

The propulsion system can be reconfigured by removing two bolts at the attachment point of each boom.

#### Removing a Propulsion System:

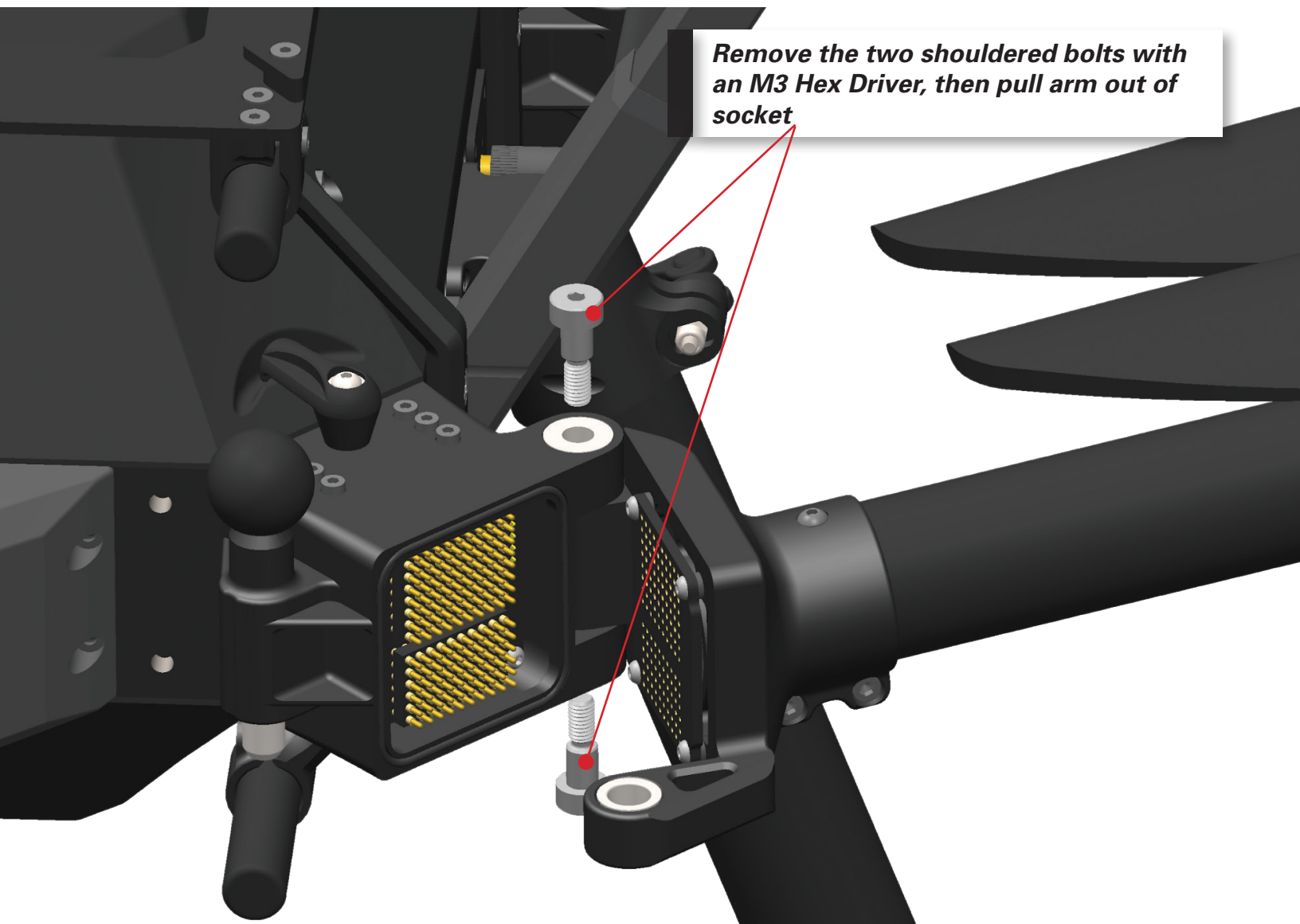
- Simply remove the two shouldered bolts with a M3 hex driver.
- Repeat for each arm



**Installing a Propulsion System:**

- Add a small amount of blue thread locker on the threads of the two shouldered bolts.
- Install arm into socket from the side.
- Partially tighten each bolt.
- Close the arm and engage the latch pin.
- Tighten both bolts.

*Remove the two shouldered bolts with an M3 Hex Driver, then pull arm out of socket*



This process allows users to easily replace a particular propulsion system in the event that damage has occurred, as well as swap out entire propulsion systems when the scope of the operation has changed. This technology allows a user to completely change out the propulsion system all together without the need to ever press a single button or change a single configuration. This is all done automatically within PRISM's onboard computing software.

The WattsQGC Application on the EchoSky Mobile includes a system status screen to verify the mounting location, functionality, and individual flight time of each propulsion boom system. This can be seen in the PRISM menu of the WattsQGC application.

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## 7.6 FLIGHT BATTERY

PRISM uses 2x 12 cell LiPo batteries for flight. It is imperative that both batteries are of the same specification, and have a similar amount of charge/discharge cycles. For this reason, the 2 batteries that make up a single flight pack should be kept as a matching set. Unless 1 battery fails or begins to underperform, the flight pack should not be split up.

More details about the use of batteries, as well as maintenance and care are provided in **Chapter 3**.

---

## 7.7 ELECTRICAL SYSTEMS

Power from the flight packs is connected by the main power plugs to a central power distribution board. This PDB is rated to 400 amps continuous power input. Each arm socket is rated to 100A continuous current each, but the maximum amount of amperage draw as seen from the most power hungry propulsion system is not even half of that. This 2:1 ratio allows the user to fly confidently, knowing that the electrical system can handle extreme power loads.

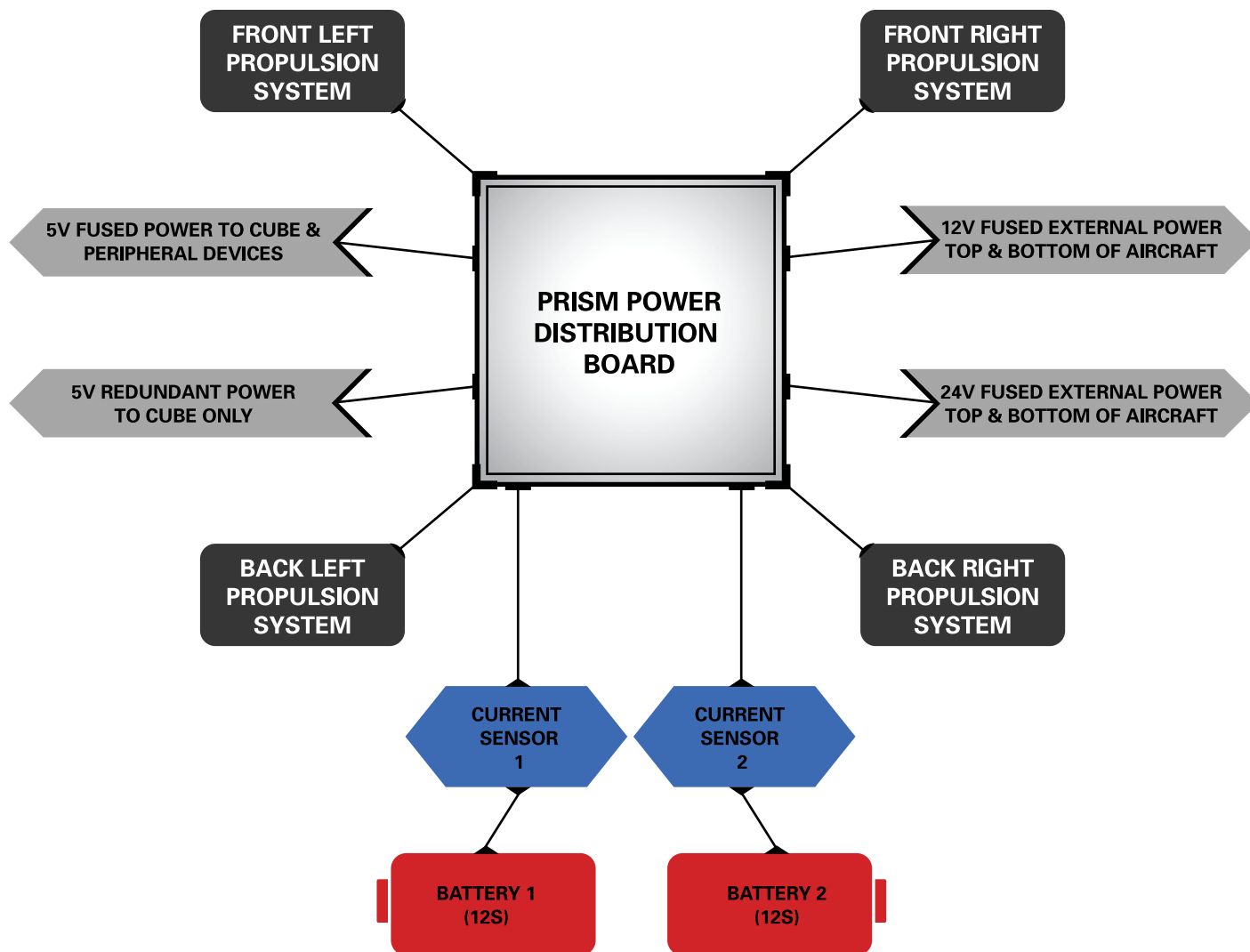
The Flight controller is powered directly from the flight batteries through two individual 5V Regulator systems. These regulator systems are completely separate, which allows redundancy in the event that one fails in flight.

Each of the U8ii propulsion units are connected directly to the PDB and receive power directly from the Flight Batteries through the small spring loaded pins. These pins allow power, data, and motor PWM to be carried from the propulsion system up to the Cube. All data connections, PWM signals, and power are configured in a redundant manner, meaning that a multitude of pins can fail and the aircraft will stay airborne.

Voltage and current draw information is calculated by two current sensors installed between the power distribution board and the battery packs. (See Figure 6 for a wiring schematic). This allows the aircraft to be able to read current from both batteries individually. Voltage however is always averaged between the two batteries.



■ Figure 8: PRISM POWER CIRCUIT DIAGRAM



## 7.8 COMMUNICATIONS LINK C2

PRISM RPAS ships with the EchoSky Mobile running the WattsGQC control app and interface.

### 7.8.1 ECHOSKY MOBILE

This all in one handheld system provides simultaneous control uplink and video and telemetry downlink via a bi-directional 2.4 GHz data link.

The EchoSky system is made up of two main components: the Air Unit and the Ground Unit. The Air unit is installed on the aircraft and communicates via MAVLINK with Cube flight controller.

The Air Unit receives and transfers command and control inputs to the flight controller. The Ground unit is a handheld controller with an integrated touch screen.

## 7.9 PAYLOADS

PRISM RPAS has been designed to operate safely while carrying a selection of payloads up to 24 lbs (10.88 kg) at sea level, when configured with the TMotor U8ii Coaxial propulsion system. Certain payloads may replace or remove the original PRISM T-bar landing gear system.

### NOTE:

**If the payload selected does not incorporate landing gear, the operator should contact the manufacturer to discuss the addition of appropriately mounted landing gear.**

### 7.10 ECHOSKY MOBILE REMOTE PILOT STATION

PRISM RPA ships with the EchoSky Mobile RPS (Figure 11), a handheld control station with an integrated Android 7.1 device running the WattsQGC proprietary app. The EchoSky Mobile allows the pilot to command RPA movement by manipulating the two control sticks, and by pressing buttons and moving dials built into the grips. The integrated seven-inch, HD touchscreen provides an interface for additional settings, commands, and inputs through the WattsQGC application. It also broadcasts video feeds and telemetry from PRISM and its payloads with minimal latency.

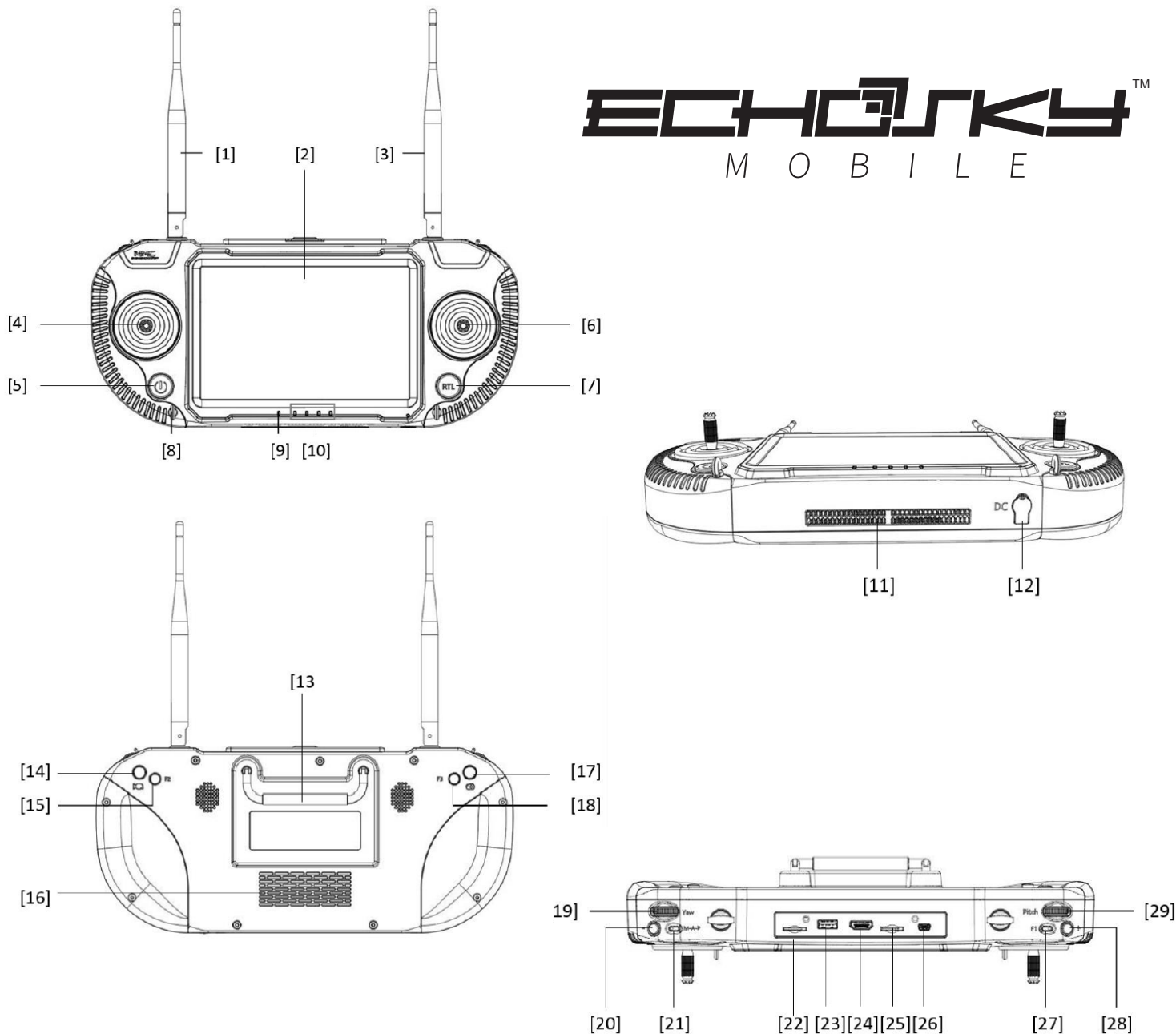
The EchoSky weighs 2.6 pounds (1.2 kg), and its dimensions are 12.6" x 5.6" x 2.1" (32 cm x 14.2 cm x 5.4 cm). It features a six-core, high-performance processor, and a large-capacity rechargeable lithium battery with a five-hour endurance. The handset





has an IP52 rating, making it protected against dust and resistant to light rain and moisture spray. It may be safely operated in temperatures from -4 degrees Fahrenheit (-20 degrees Celcius) to 131 degrees F (55 degrees C).

■ **Figure 9-12: ECHOSKY MOBILE RPS**



**ECHOSKY™**  
M O B I L E

The Echosky Mobile is a re-branded Etlas Mobile Manufactured by MMC. The Echosky Mobile handset is FCC, CE and Red Compliant. For all compliance documents please see supplements 1-3.



**Table 9: COMPONENT LIST FOR ECHOSKY MOBILE**

**ECHOSKY<sup>TM</sup> 4**

<b>[1,3]:</b> Radio/video Tx and Rx antennas	<b>[15,18,27,28]:</b> User-customizable function buttons
<b>[2]:</b> 7" Integrated LCD screen	<b>[16]:</b> Cooling fan inlet - keep clear
<b>[4,6]:</b> Flight joysticks (left stick: throttle, yaw) (right stick: pitch, roll)	<b>[17]:</b> Record Start/Stop button
<b>[5]:</b> On/Off button (short press, then press and hold to power on/off)	<b>[19]:</b> Gimbal yaw/heading wheel
<b>[7]:</b> RTL button (long press to initiate; short press to cancel)	<b>[20,28]:</b> Gimbal zoom adjustment
<b>[8]:</b> Strap Hook	<b>[21]:</b> Flight mode switch
<b>[9]:</b> LED status indicator	<b>[22]:</b> Micro SIM slot (not used)
<b>[10]:</b> RPS battery level indicator	<b>[23]:</b> USB 2.0 interface for optional RTK
<b>[11]:</b> Cooling fan outlet - keep clear	<b>[24]:</b> HDMI Out for external display
<b>[12]:</b> DC Charging Port	<b>[25]:</b> MicroSD slot for App updates
<b>[13]:</b> Carrying handle	<b>[26]:</b> UART serial port (not used)
<b>[14]:</b> Shutter button	<b>[29]:</b> Gimbal tilt wheel



1. The EchoSky Mobile ships with a default Mode 2 stick configuration in which the left stick controls throttle and yaw, and the right stick controls the tilt direction about the horizontal axes.
2. The Flight Mode switch (21) enables the pilot to switch between programmable flight modes. The default modes assigned to the switch positions are Altitude Hold, Altitude Hold, and Position Hold. Users may customize these values in the WattsQGC app.
3. The RTL button commands an immediate RTL after a long press, bringing the aircraft back to the take off site and automatically landing. The user can cancel an initiated RTL with another short press of the RTL button. When the button is indeed activated after a long press, it illuminates blue.
4. The functions of customizable buttons can be assigned in the WattsQGC application. Please note that the WattsQGC app is being under development, and future updates may assign specific purposes to these buttons.
5. The Touch screen monitor displays aircraft telemetry and video feed, while allowing the pilot to adjust settings, plan missions and send commands to the RPA. The user may enter full-screen mode and clear the heads-up display (HUD) on the main screen by tapping twice at the center of the screen. The user brings back the HUD by tapping twice on the screen again.
6. Press, then press and hold the power button on the RPS to turn it on and off. Please note that after starting the WattsQGC app, it may take 20-30 seconds for the program to finish loading operational parameters from the aircraft.
7. The EchoSky Mobile handset may be charged with the included DC charger.

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## 7.11 CONNECTING THE ECHOSKY MOBILE TO A WiFi NETWORK

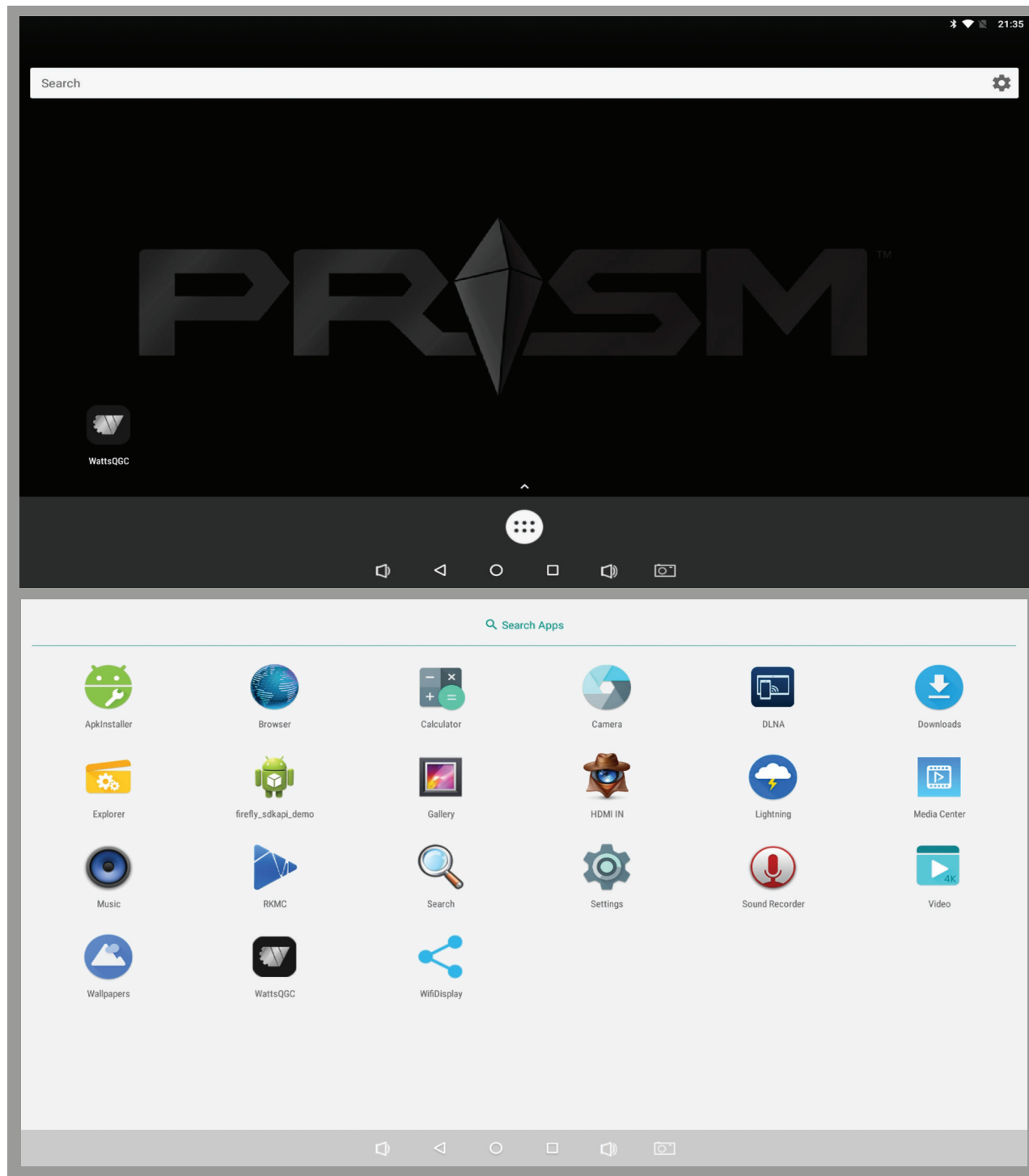
The EchoSky Mobile handset is built around a tablet that runs the Android operating system. This, when connected to the internet, allows applications such as WattsQGC to be used to its full potential. When connected to the internet, the WattsQGC application is capable of updating itself to the latest firmware, as well as the ability to show satellite imagery inside of the application.

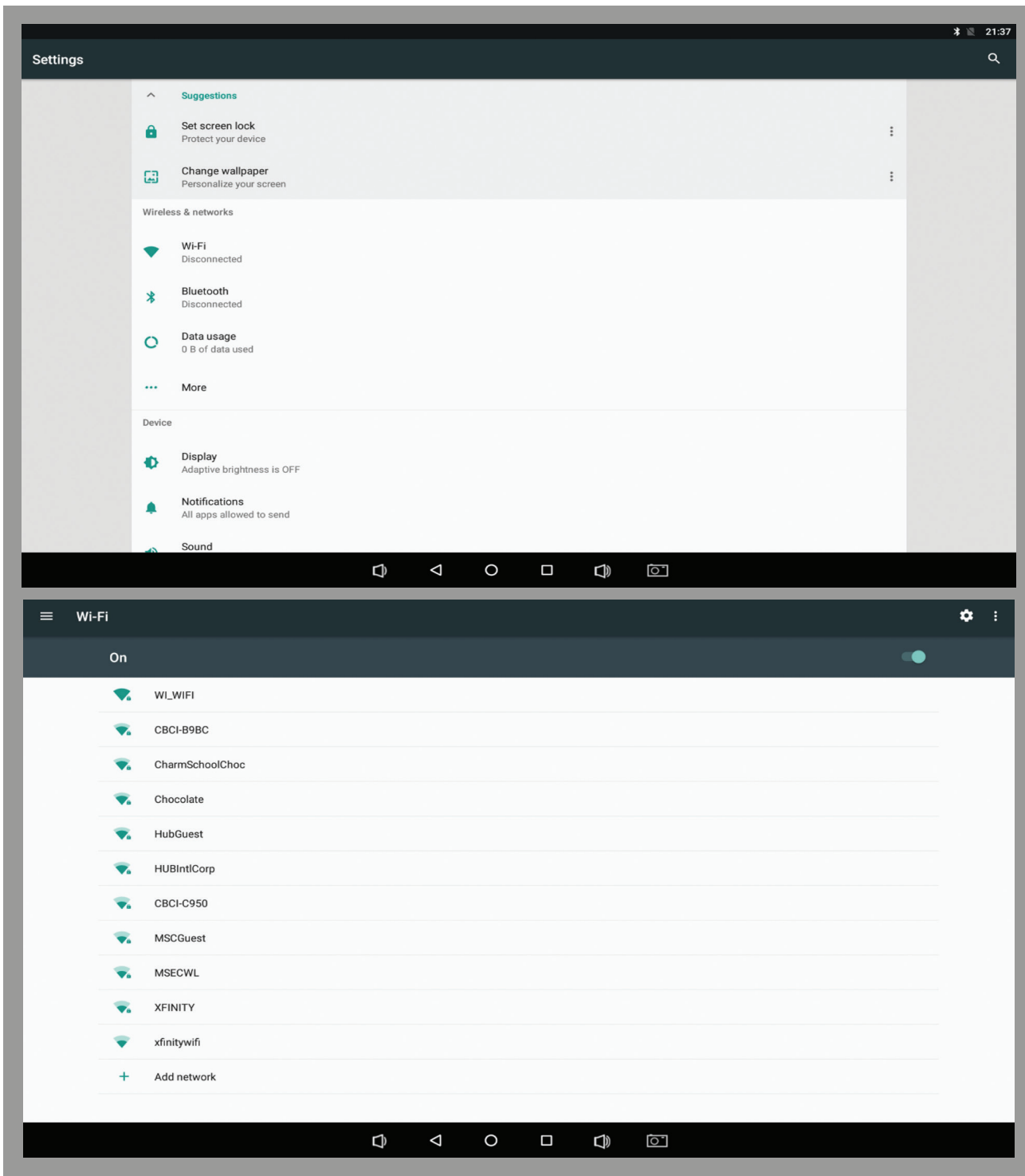
In order to connect the EchoSky Mobile tablet to the internet, simply access the Settings menu in the Android tablet by pressing the 6 dots icon on the main menu, navigate to WiFi, find your network that you would like to connect to, and type in the network password. It is highly recommended that you connect to a WiFi network to ensure the best experience possible with PRISM and the EchoSky Mobile RPS.

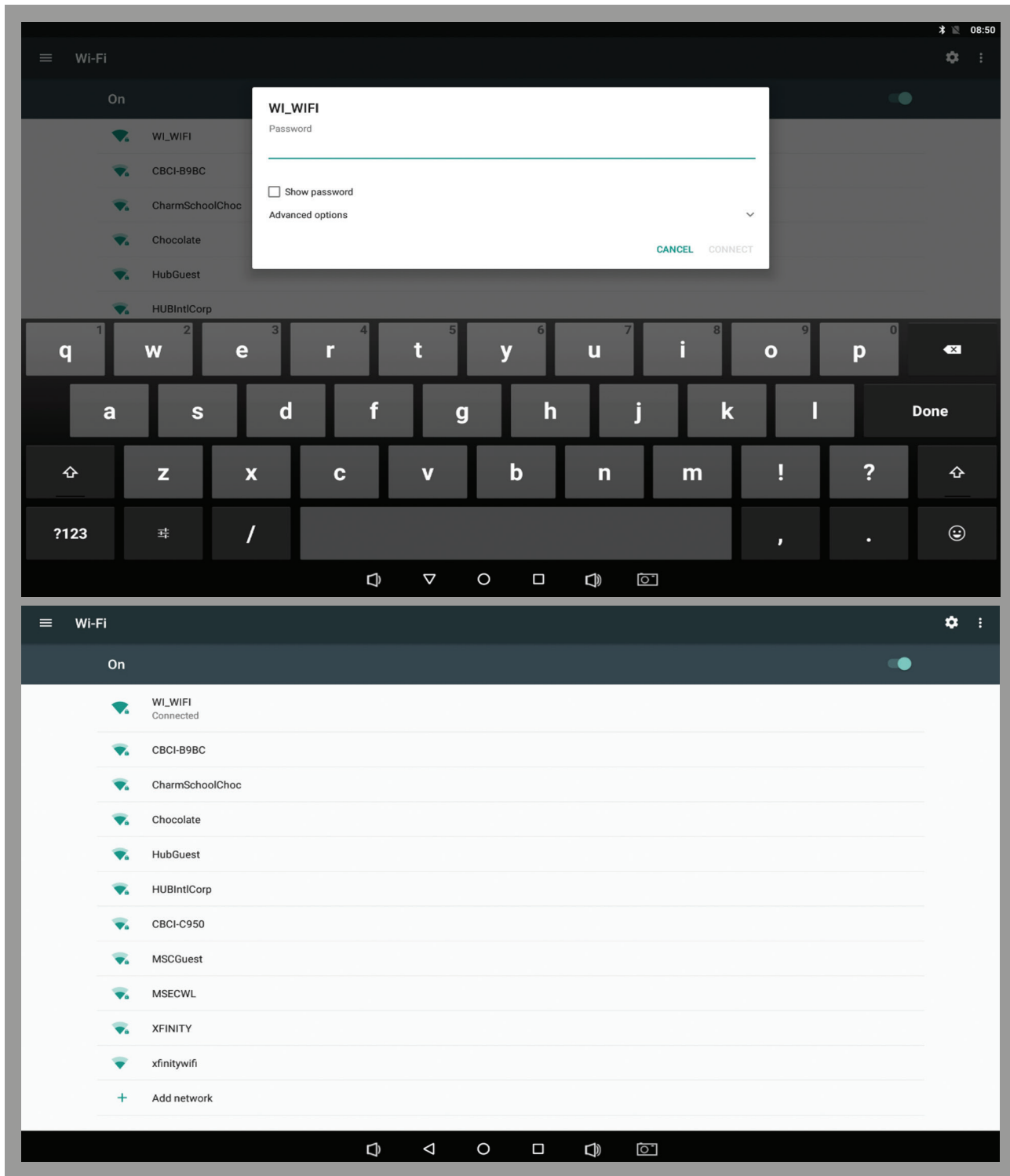


**NOTE:**

The EchoSky Mobile handset is only capable of connecting to 5.8GHz WiFi networks, which means that tethering from some mobile devices (such as Apple iPhones) may be unavailable. Please keep this in mind when considering the logistics of your operations.





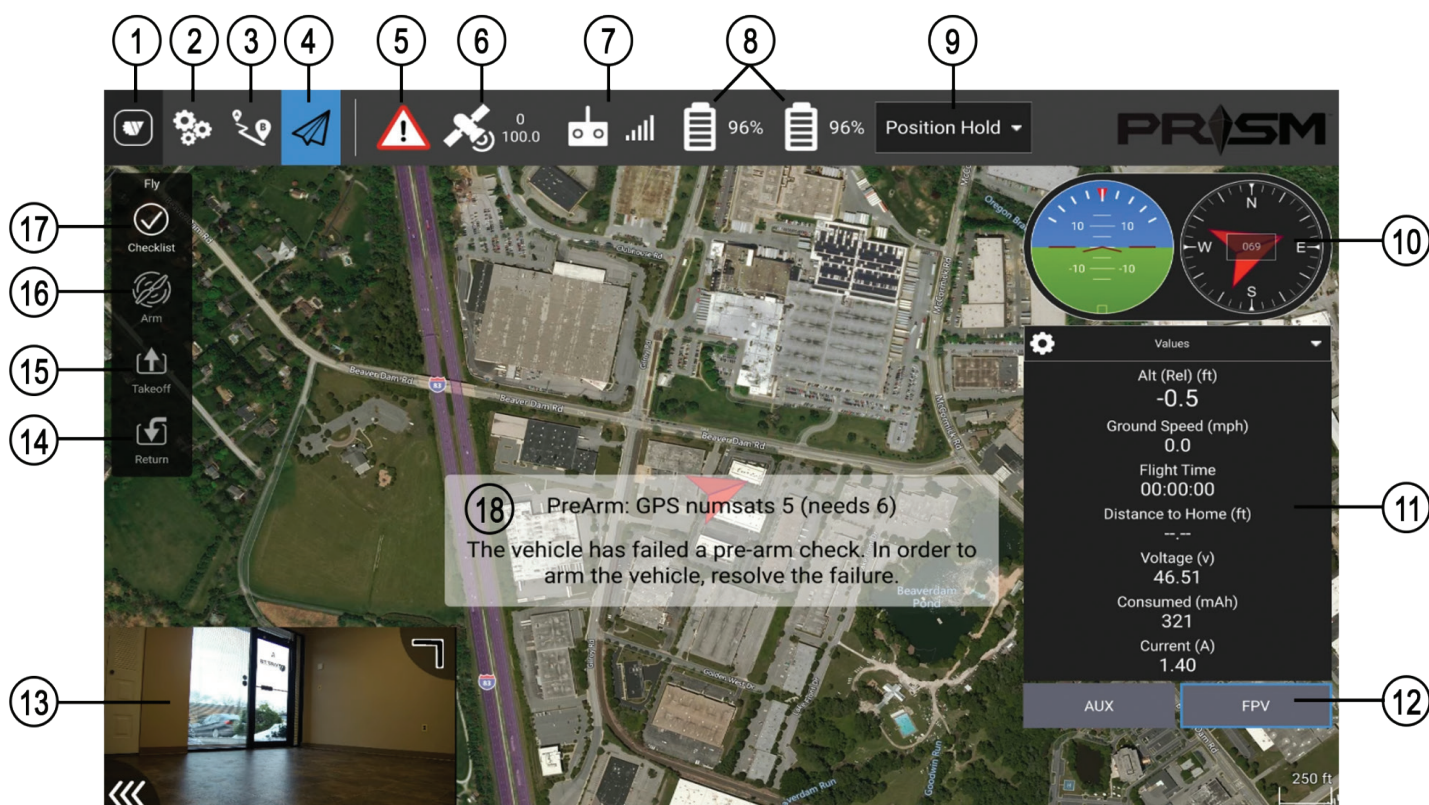


## 7.12 THE WATTS QGC APPLICATION

The WattsQGC control application is Watts Innovations' control app designed specifically for PRISM RPS, and is based on the powerful QGroundControl open source flight-planning software.

NOTE: In an effort to provide users with the best possible experience with PRISM, the WattsQGC application will constantly be under development. This means that there will be regular updates to improve functionality, provide more features, and overall improve the user experience. The screenshots and descriptions as shown in this document may become outdated over time. For the latest information on firmware updates, bug fixes, and software improvements, be sure to visit our [Watts Innovations Knowledge Base](#).

■ Figure 13: WATTSQGC APPLICATION LAYOUT



**Table 10: WATTSQGC FEATURES**

<b>[1]:</b> WattsQGC Application Settings	<b>[10]:</b> Artificial Horizon & Heading Indicator (magnetic)
<b>[2]:</b> PRISM Vehicle Settings	<b>[11]:</b> Real-Time Telemetry Values
<b>[3]:</b> Automated Flight Setup	<b>[12]:</b> Camera Input Source Selector
<b>[4]:</b> Main Fly Screen / Fly Menu	<b>[13]:</b> Picture-in-Picture
<b>[5]:</b> MAVLink warnings/notifications	<b>[14]:</b> RTL/Land button
<b>[6]:</b> GPS Satellite Status	<b>[15]:</b> Takeoff button
<b>[7]:</b> RSSI for RC/Video Link	<b>[16]:</b> Arm Motors button
<b>[8]:</b> Battery % remaining	<b>[17]:</b> Pre-flight Checklist
<b>[9]:</b> Flight Mode	<b>[18]:</b> Warning text

## 7.12.1 WATTSQGC APPLICATION SETTINGS

### (i) General Settings

In this menu, the user can adjust the application's appearance, language, default measurement units, UI scaling, and other settings which affect the user's interaction with the flight-planning application.

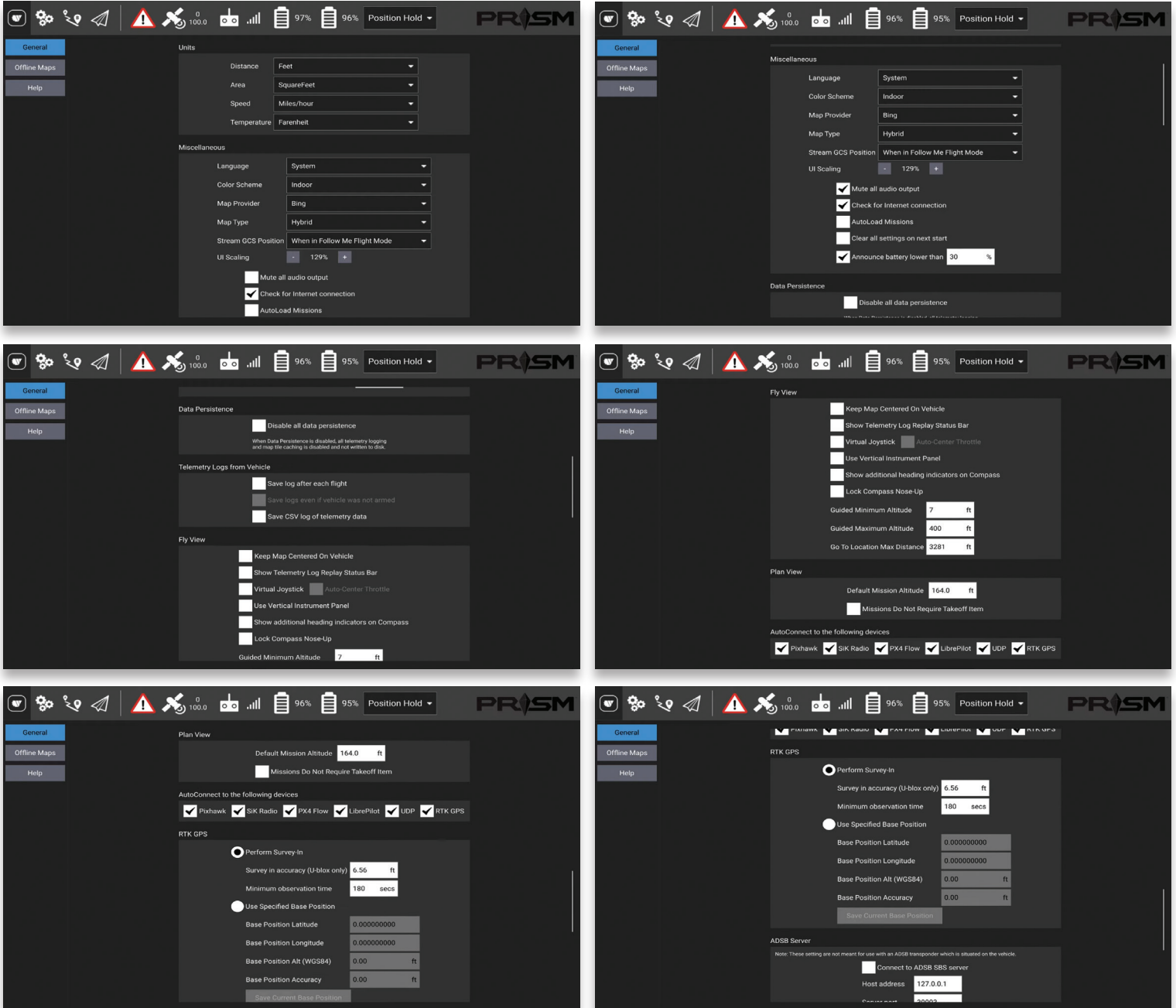
This menu is also where the user will manage flight data for logging purposes, adjust RTK settings, and video output settings for video streaming from the EchoSky Mobile RPS.

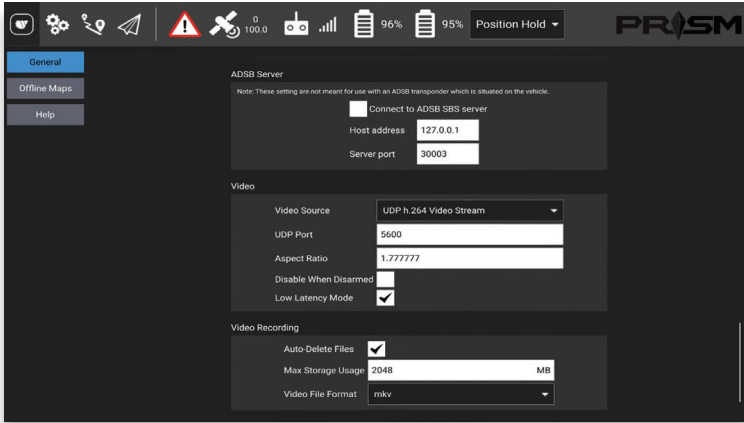
Note that the following screenshots are shown with the Indoor color scheme (Dark Mode). WattsQGC by default is set to the Outdoor color scheme which assists in viewing in bright sunlight. The Indoor color scheme may be chosen for operations that take place at night or in low light conditions.





■ Figure 14-20: WATTSQGC APPLICATION SETTINGS-GENERAL

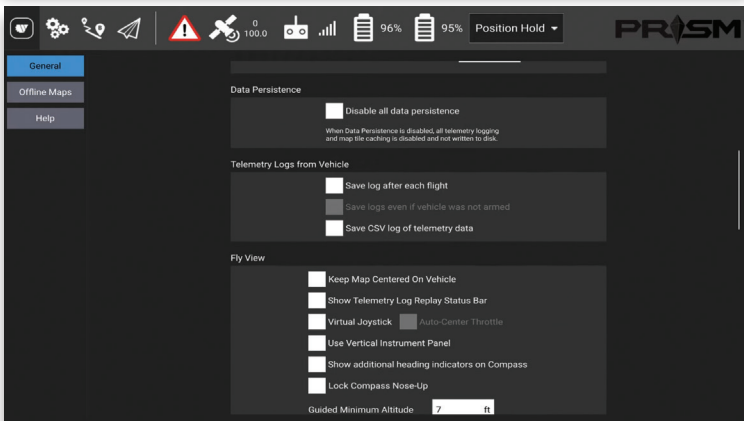
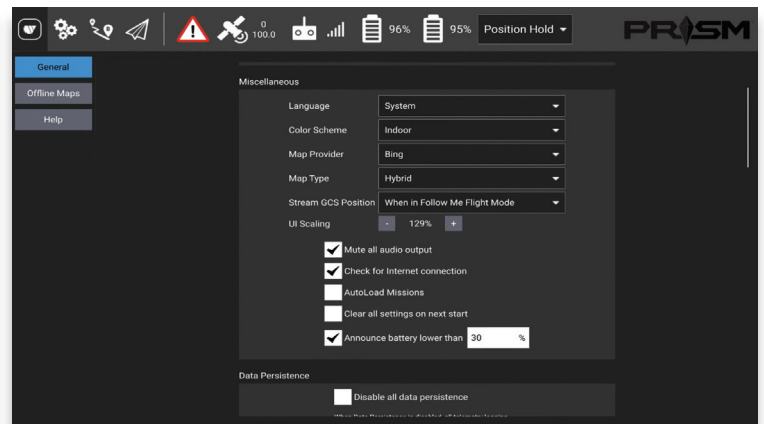
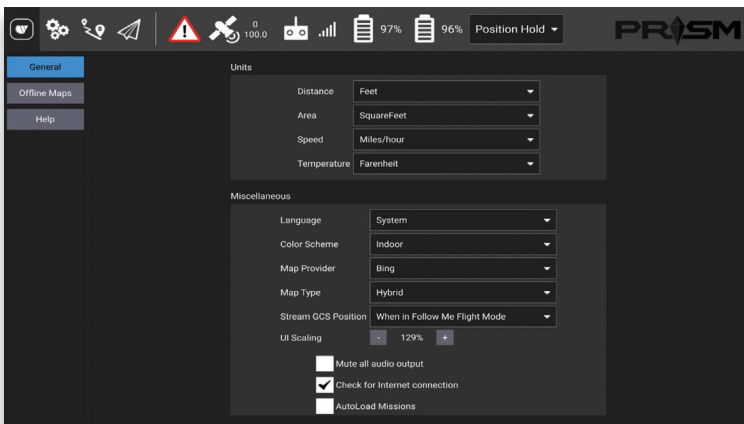




**(ii) Offline Maps**

The user may cache map data for future use by selecting “Add New Set,” defining maximum and minimum zoom levels in the following screen, and downloading the maps to the device. The user may also import or export existing map sets. This feature is useful for mission planning for areas where mobile data and wireless networks are not available.

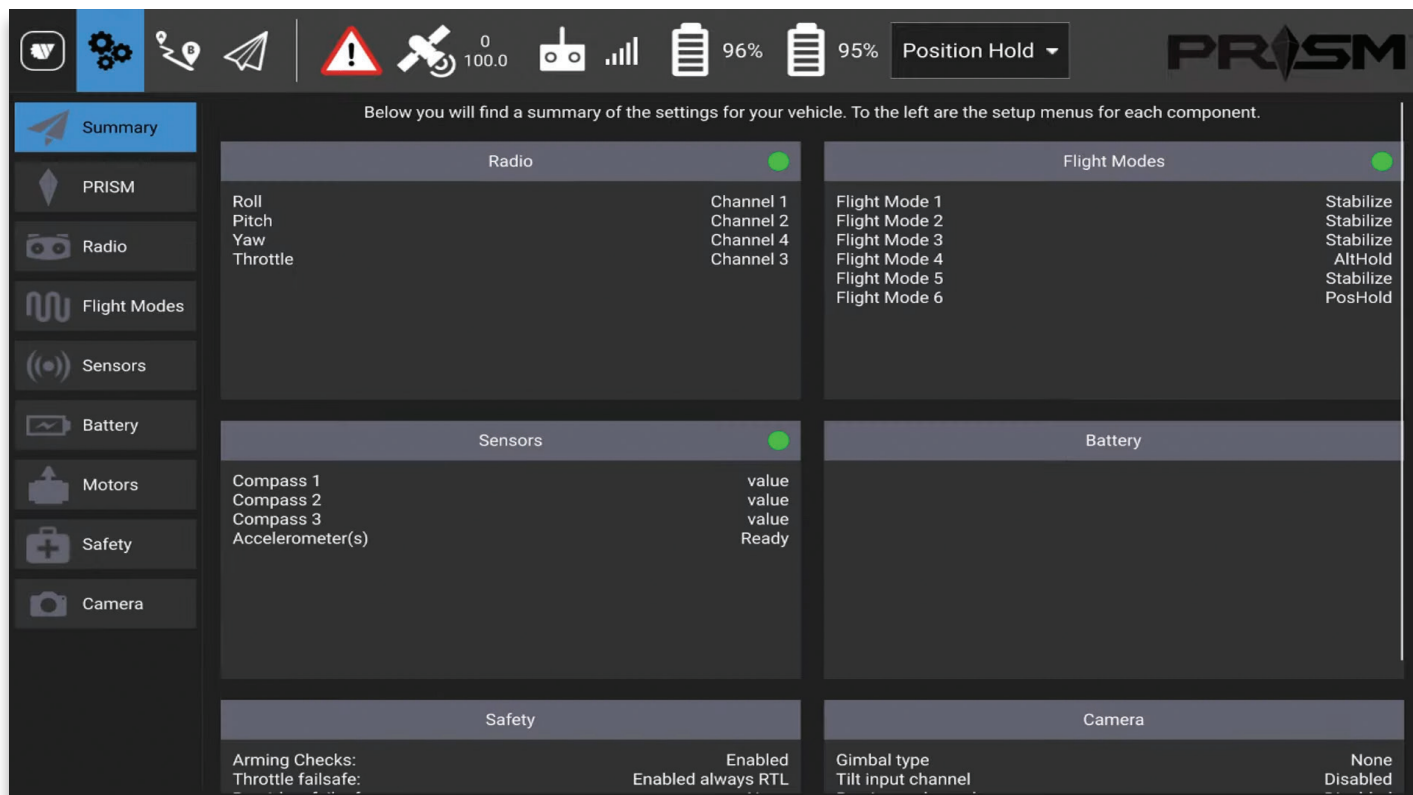
**Figure 21-23: OFFLINE MAPS**



## 7.12.2 PRISM VEHICLE SETTINGS

### (i) Summary

This screen shows a status summary of the aircraft’s active on-board systems and settings.



### (ii) PRISM

PRISM screen displays the real-time status of the vehicle, including the motor configuration (Quadcopter vs. Coaxial X8), aircraft firmware version, total flight time of the aircraft, and total flight time for each motor/arm boom.

This screen shows status indicators for each equipped motor. Since the propulsion system components are hard-coded to operate at specific mounting locations, this screen will indicate if any propulsion systems have been installed in the wrong place (e.g.: If the front-right hard-coded boom arm has been mounted on PRISM airframe’s rear-left location). If a propulsion boom’s mounted location is correct, all motors will be green. If the location is incorrect, or the propulsion system is no longer connected, the corresponding arm location will be indicated in red. This will prevent the user from arming or taking off.



Users will download and update PRISM's firmware from this screen, and may also change the default camera view on the main Fly screen by choosing between AUX and FPV in the drop-down menu.

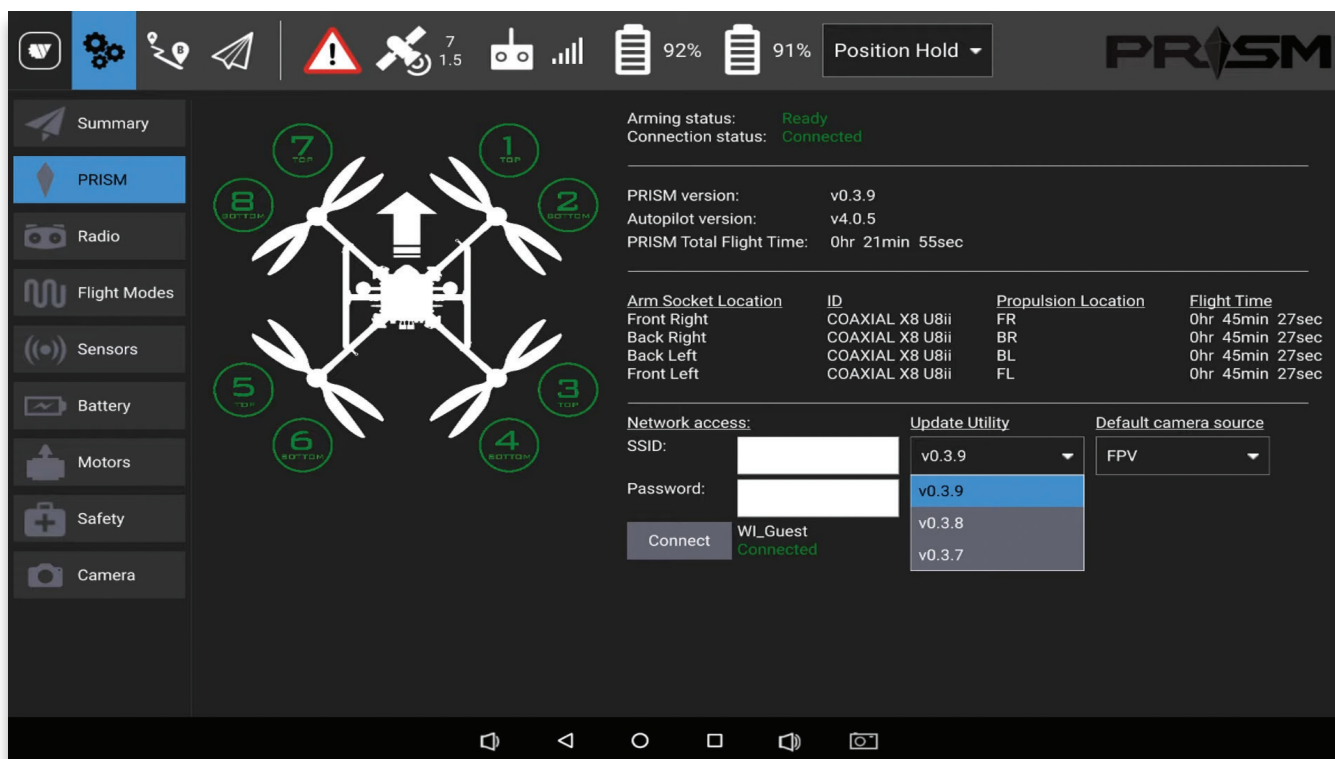
## FIRMWARE UPDATES

Watts Innovations will frequently release new updates for the onboard PRISM firmware. These updates will include new feature implementations, improvements and bug fixes. It is highly recommended that users continually update both WattsQGC as well as the onboard PRISM firmware to ensure optimal performance and the best user experience possible.

## UPDATING PRISM FIRMWARE WITH THE ECHOSKY MOBILE HANDSET

1. Ensure the aircraft and RPS are powered on with sufficient power for the duration of the update.
2. Connect PRISM's onboard companion computer to a wireless network. This is done by entering the network SSID and password into the Network Access fields in PRISM menu of the Vehicle Settings, and tapping "Connect." The SSID and the word "Connected" in green will display upon successful connection.

■ Figure 24: PRISM FIRMWARE UPDATE SCREEN



3. Select "Check for updates" under the Update Utility. The system will prompt the user to power off the EchoSky Mobile to prevent interference with the WiFi data download.
4. Power off the EchoSky Mobile by tapping the power button, then tapping it and holding it until the handset powers off.
5. Restart the EchoSky Mobile. During the rebooting process, the companion computer will download the update and cache it for transfer to PRISM. Restart the WattsQGC application and allow it to fully connect to the RPA (about 30 seconds).
6. Access the Aircraft Settings and PRISM menu again. Verify that the new firmware version shows in the drop-down menu under the Update Utility.
7. Select the new firmware version from the drop-down menu and tap on "Update," then slide the slider to confirm. This will now begin the updating process.
8. The update will take approximately 5 minutes to install and initiate the new firmware. During this process, it will disconnect from the EchoSky Mobile RPS. **Do not disconnect the power from PRISM during the update process!** Once the process is complete, the drone will restart and the vehicle will become connected again. Now verify that the new firmware is active by verifying the PRISM Version on the same menu screen.

**NOTE:**

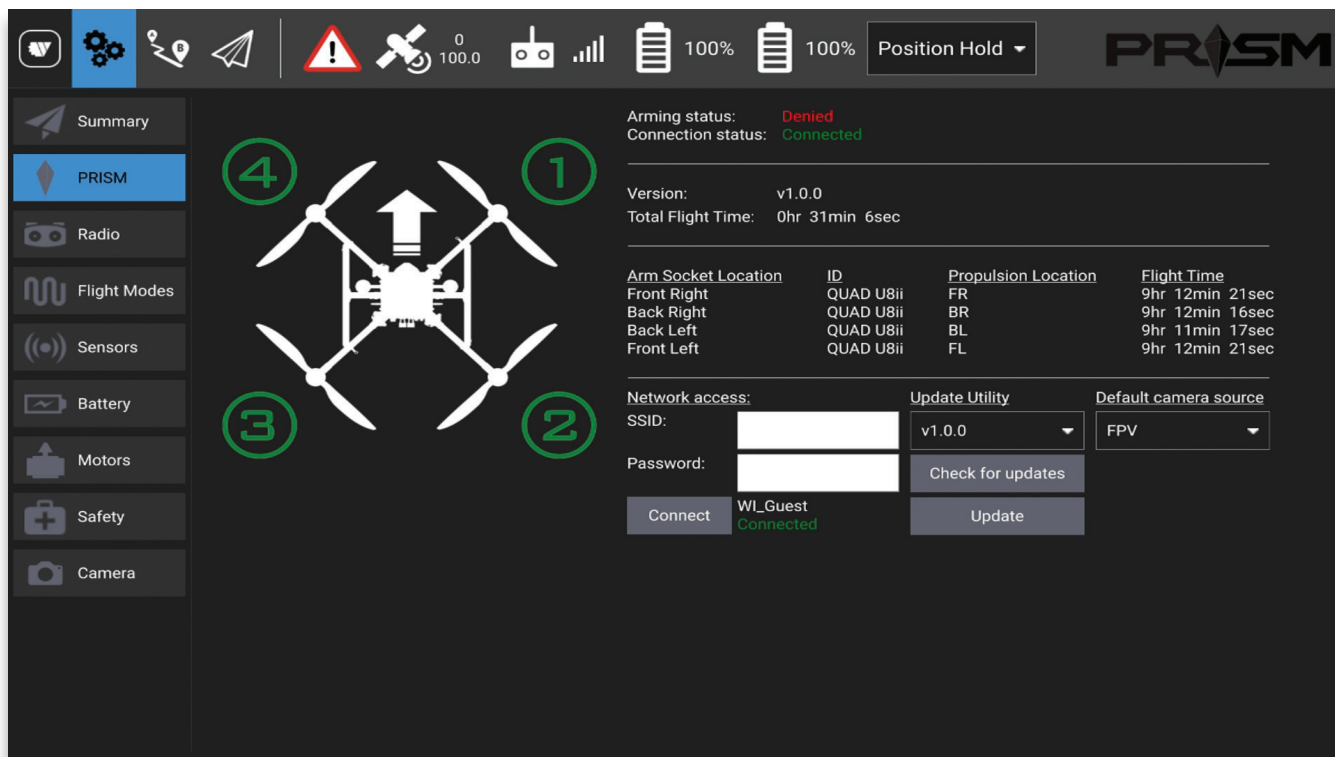
Updating to any other firmware that has not been tested & inspected by WATTS INNOVATIONS and specifically listed on the Watts Innovations Knowledge Base will void your warranty.

**NOTE:**

PRISM's autopilot software is based on Ardupilot; however, users should NOT install stock Ardupilot into PRISM. This will remove the plug-and-play functionality of PRISM and will void your warranty.



■ **Figure 25: PRISM AIRCRAFT STATUS SCREEN**



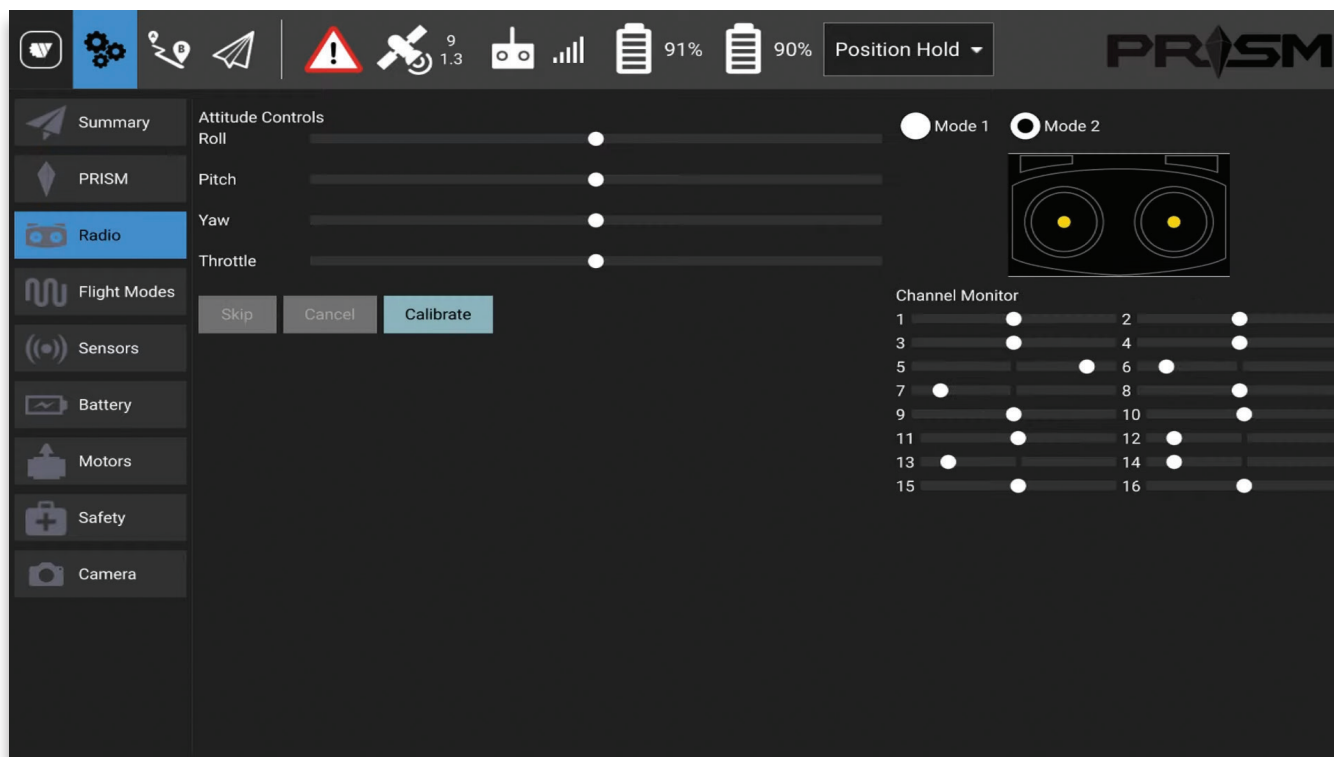
### (iii) RADIO

This menu allows users to select the control Mode for the stick inputs on the EchoSky Mobile. By default, the EchoSky Mobile is set to operate in Mode 2.

Users may use this screen to check channel inputs from the buttons, switches, and dials on the EchoSky Mobile, and to calibrate these inputs. It is recommended to perform a calibration after changing the control Mode.



■ **Figure 26: RADIO SCREEN**



#### (iv) FLIGHT MODES

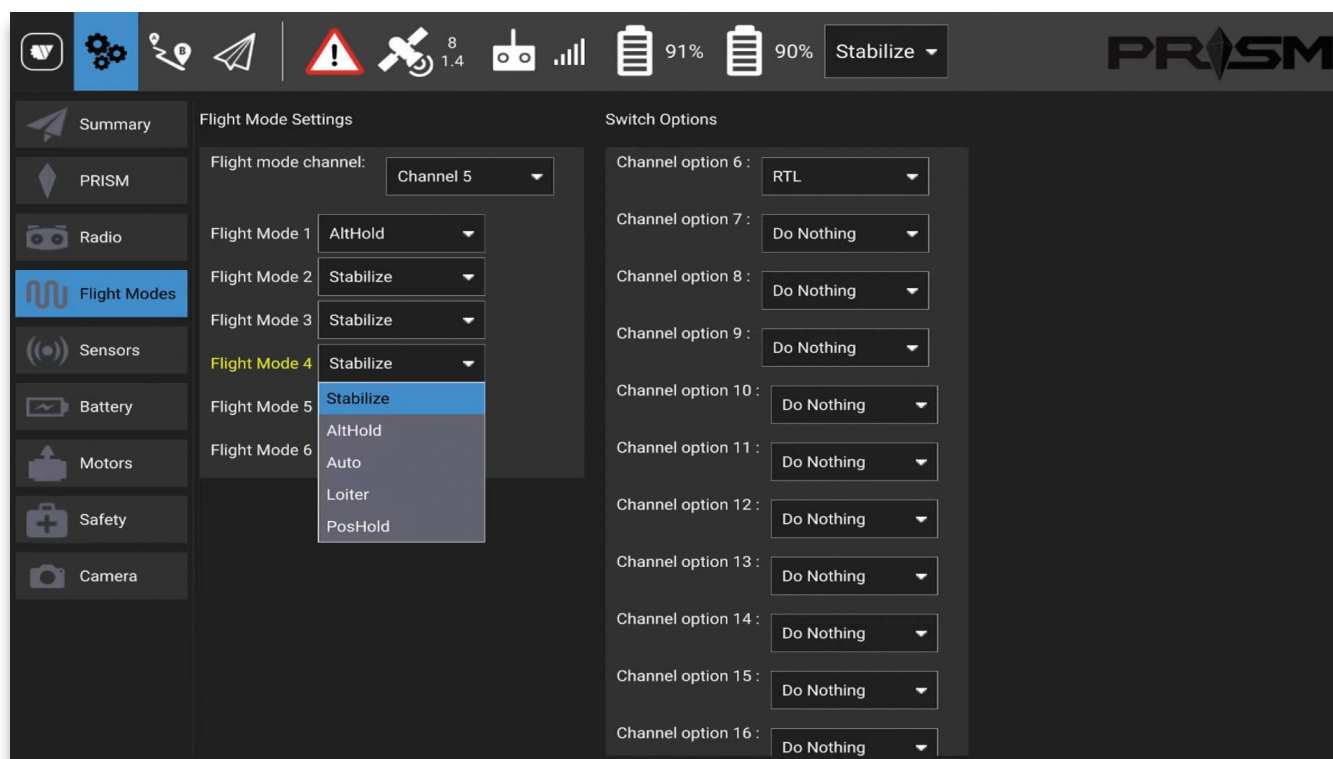
Users may customize the Flight Modes linked to the channel inputs on the EchoSky Mobile. The three-position switch on the RPS is connected to Flight Modes 1, 4, and 6, and by default these inputs are set to Altitude Hold, Altitude Hold, and Position Hold.

Channel Option 7 is the RTL button on the RPS, and should always be set to perform the RTL action.

This Flight Modes screen is also an extremely easy way to program a brushless gimbal or any other accessory that may be attached to PRISM.



■ **Figure 27: FLIGHT MODES CHANNEL SETTINGS**



## (v) SENSORS

This screen displays the status of the Accelerometer (IMU) and Compass sensors. A green dot indicates healthy sensors. Users will perform required IMU and compass calibrations from this screen. IMU calibrations are accomplished by positioning the aircraft in various attitudes while the sensors take readings. Compass calibrations require the user to rotate the aircraft randomly along the major axes until the progress bar fills up, which may take about two minutes.

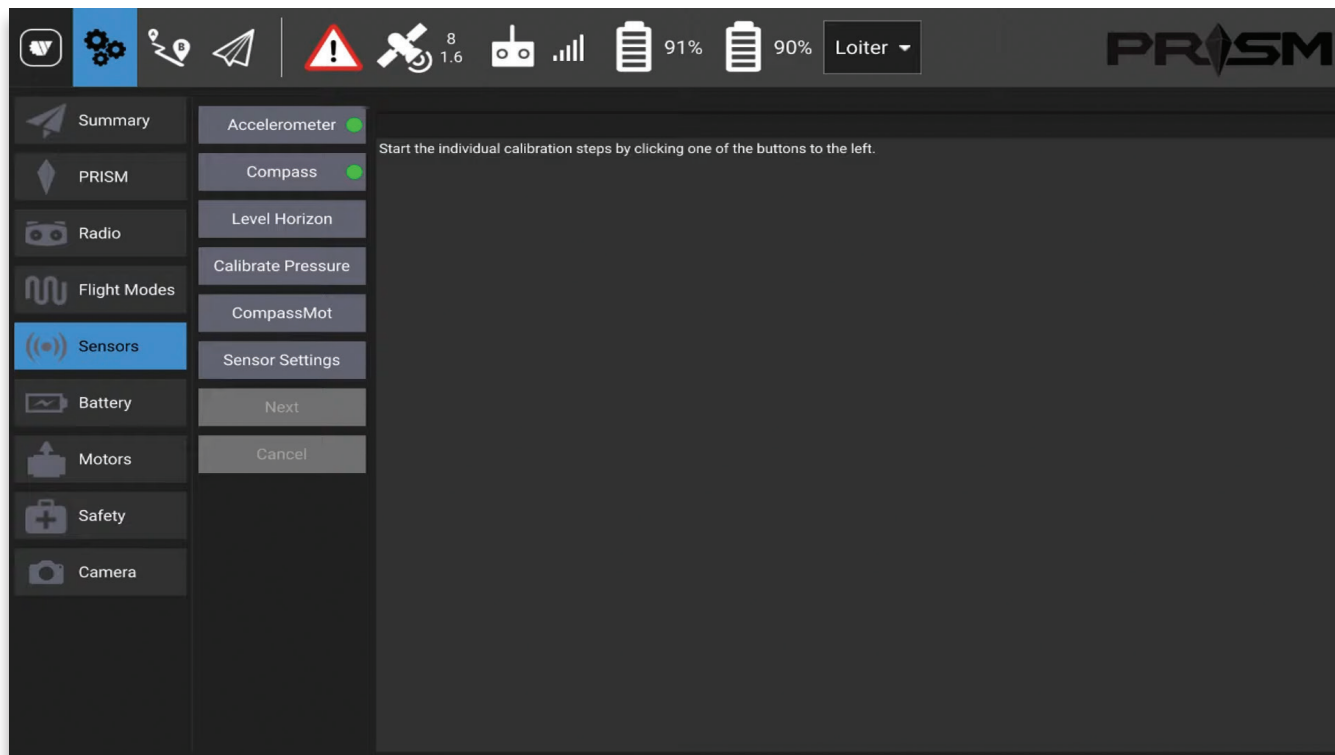
### ACCELEROMETER CALIBRATION

PRISM's accelerometers are calibrated from the factory and should not require an additional calibration before flight. It is important to note however that operations in extreme temperatures may require an additional accelerometer calibration. In order to calibrate the accelerometer, simply enter into Sensors -> Accelerometer, then follow the instructions. After placing the vehicle in each position, hold the aircraft still and press "Next", until complete. Once this is finished, a vehicle reboot must be completed in order to fly.

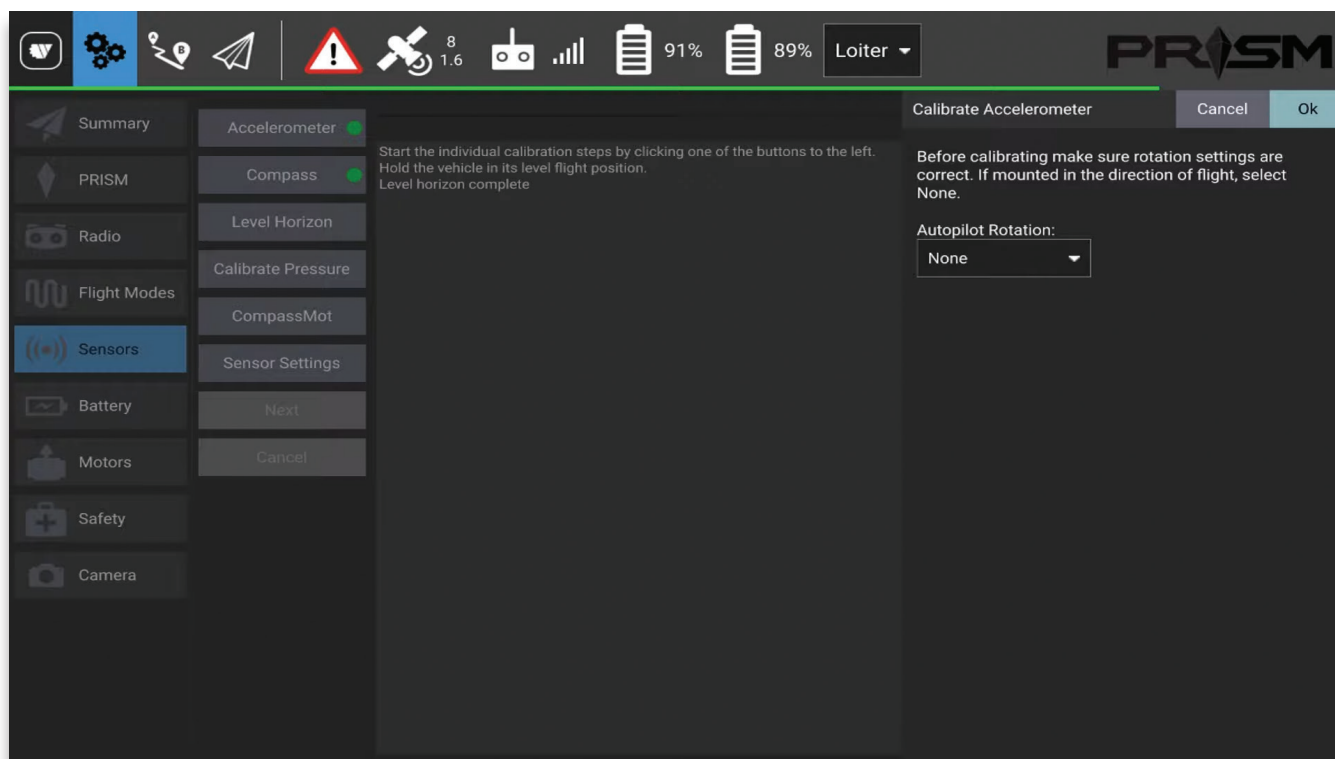


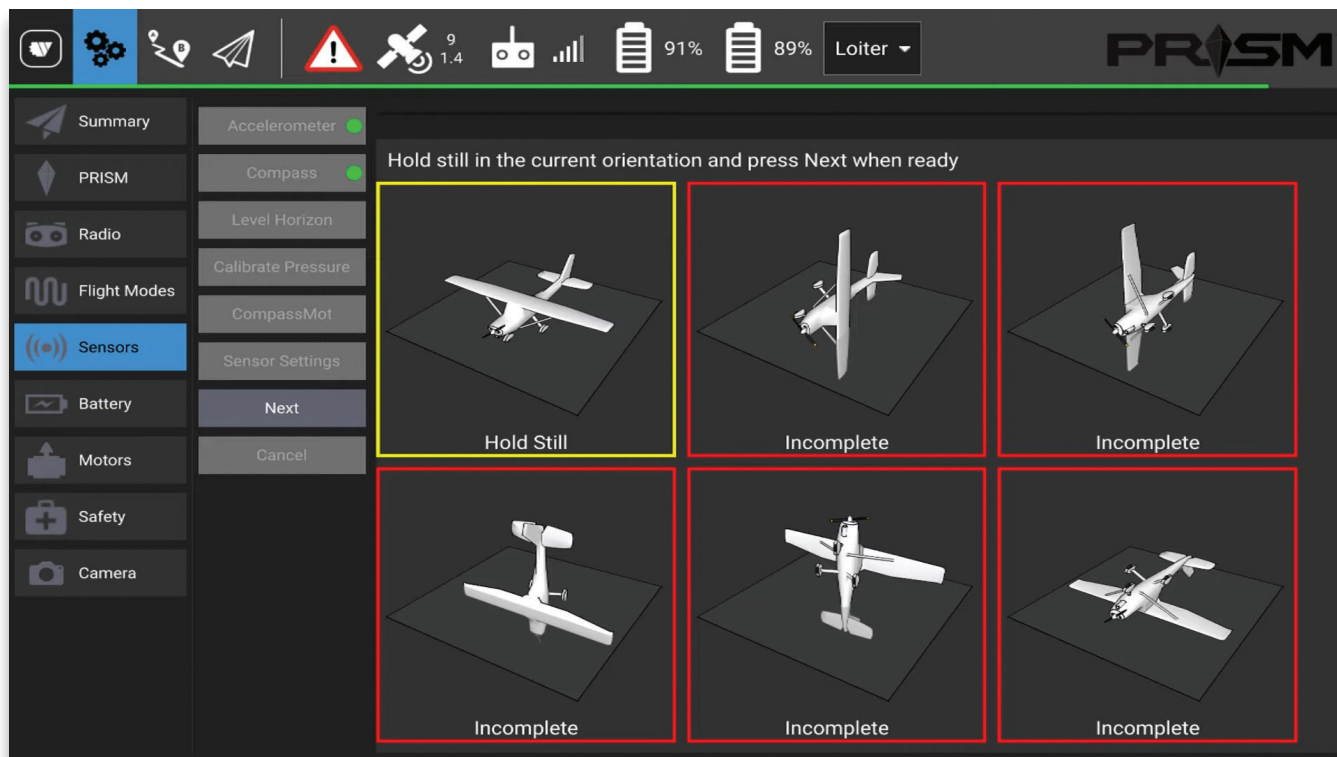


■ **Figure 28: SENSORS STATUS AND CALIBRATION SCREEN**



■ **Figure 29 & 30: ACCELEROMETER/IMU CALIBRATION SCREENS**





## COMPASS CALIBRATION

PRISM's compasses are calibrated from the factory and should not require an additional calibration before flight. It is important to note however that periodically, a user may wish to calibrate the compasses for the best performance possible. In order to calibrate the onboard compasses, simply enter the Settings -> Sensors -> Compass menu. Then click OK to begin compass calibration.

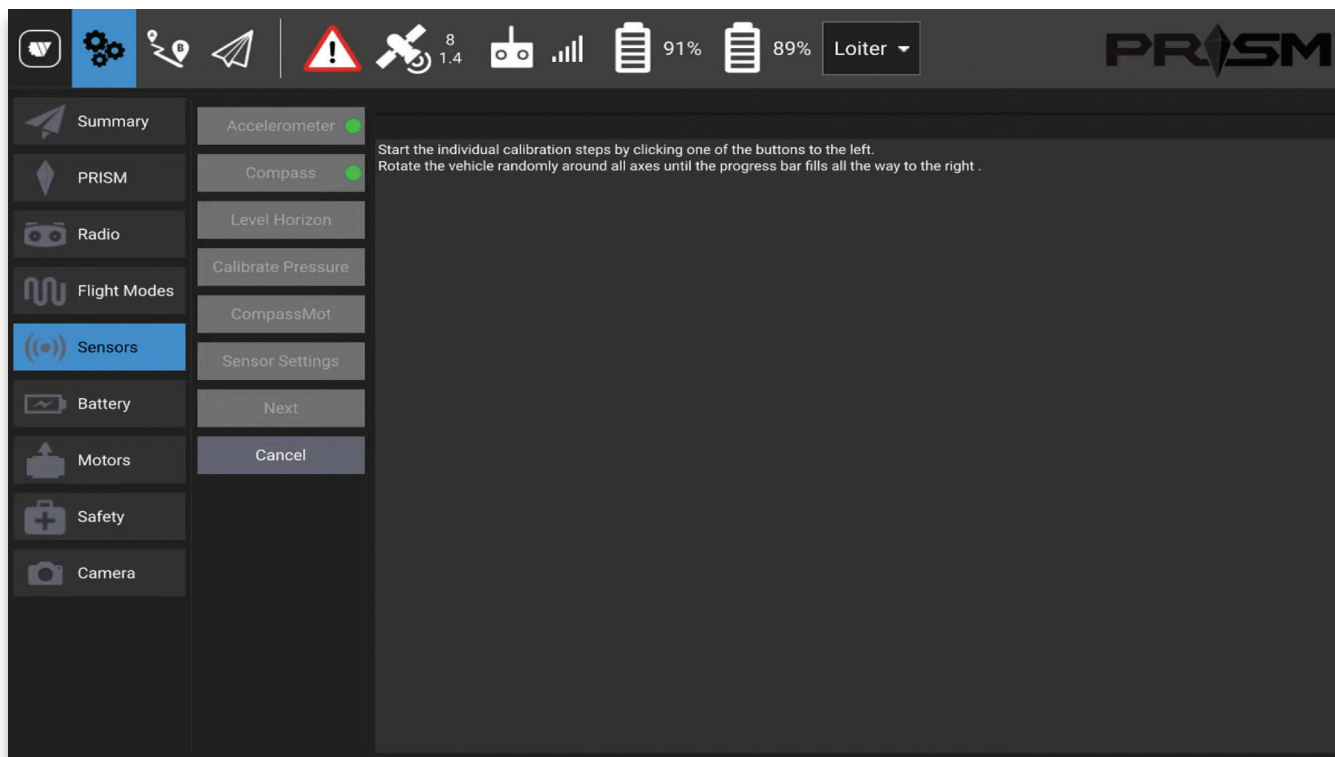
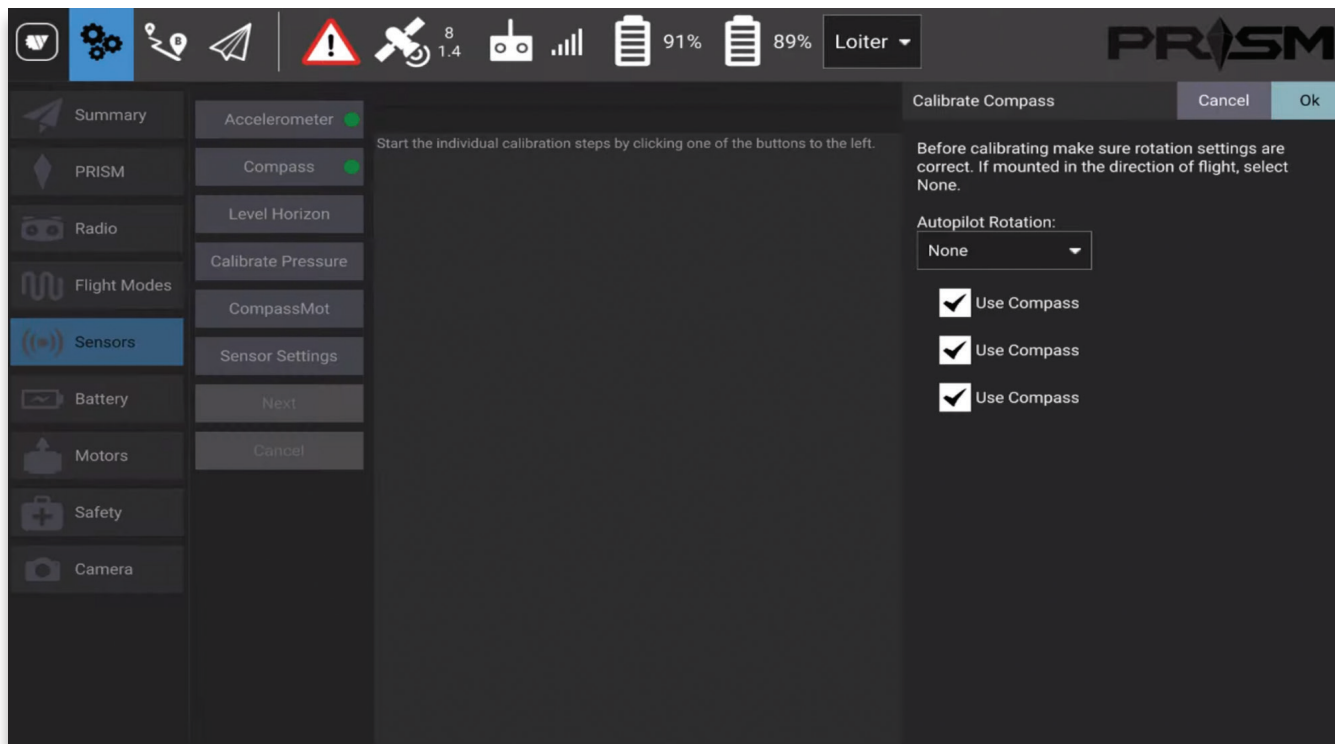
While the calibration is underway, hold the drone in the air and spin it around on all axes slowly in a circular motion. The aircraft can be rotated at random. It is important that the aircraft be rotated so that all axes are rotated during the calibration process. This may take up to a few minutes to complete, so please be patient. During the compass calibration, a status bar will be displayed. Once the calibration is complete, a readout will be shown to show the health of all three compasses.

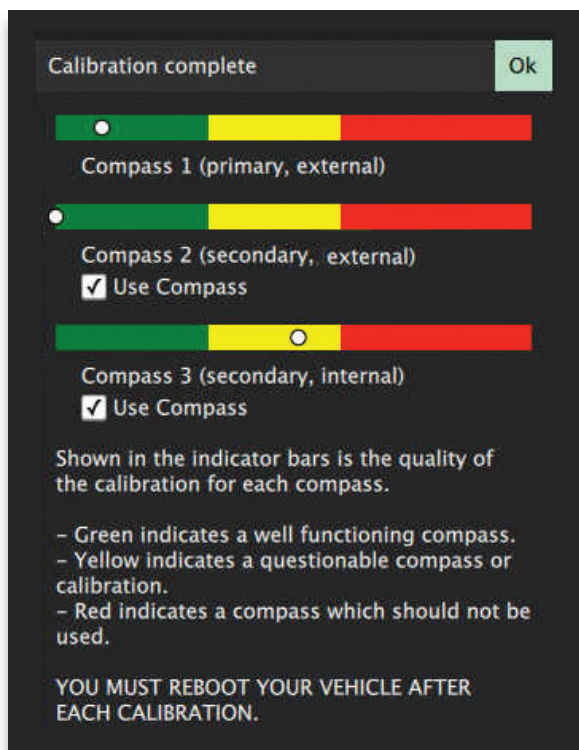
Pro-Tip: Because the aircraft can be configured with a heavy flight battery, during a compass calibration it may be easier for the operator to only plug in 1 battery in an effort to save weight. In addition, this may be performed with two people to make the process easier.

### NOTE:

**Compass 1 and Compass 2 are the external compasses, mounted on the sides of the vehicle. Compass 3 is the internal compass located in the Cube. Due to its mounting location surrounded by other electronics that may emit EMF, it is not uncommon for the Compass 3 to be displayed as poor health (Yellow to Red). This is completely normal and will not cause any in-flight issues.**

■ **Figure 31: COMPASS CALIBRATION SCREEN**

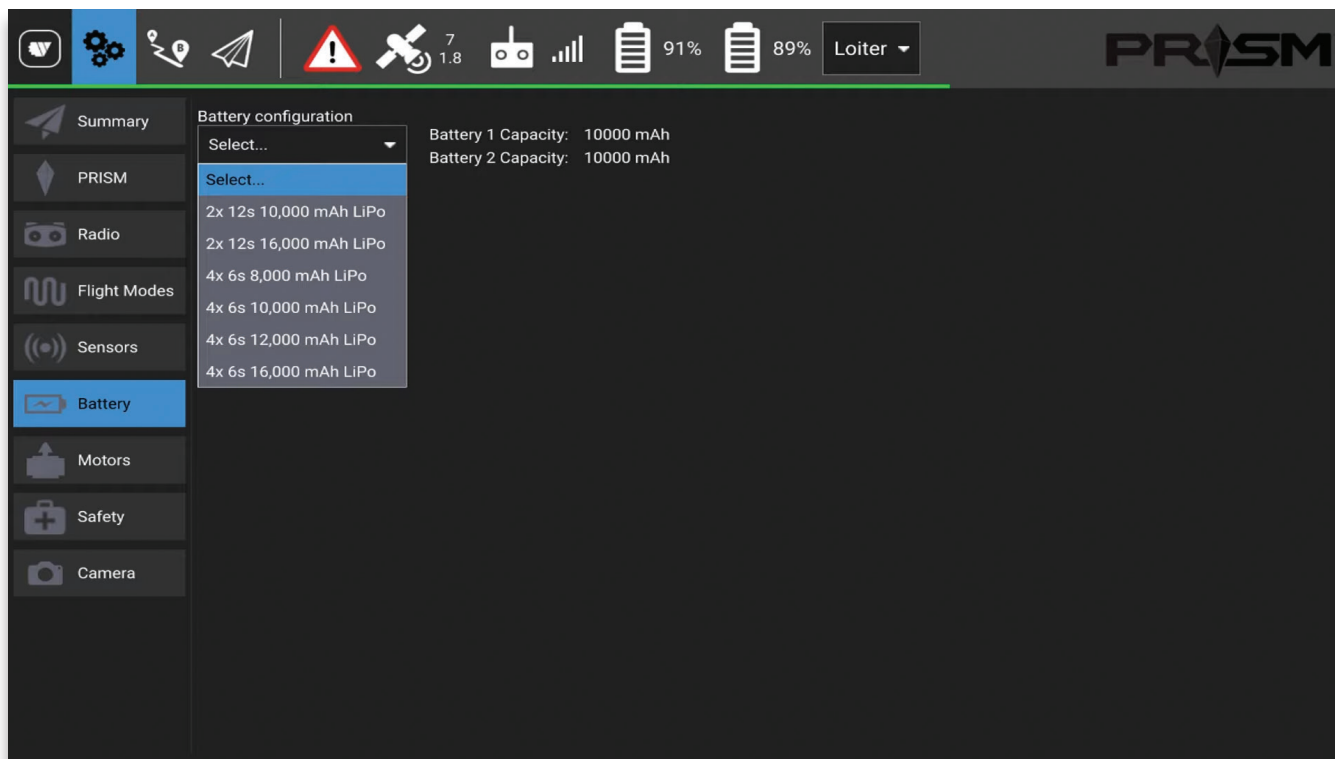




**(vi) BATTERY**

Users should select their battery payload from this screen by choosing from the compatible configurations in the drop-down list. This is a key step in ensuring the battery telemetry on the main flight screen is accurate.

■ **Figure 32: BATTERY PAYLOAD SELECTION SCREEN**



**(vii) MOTORS**

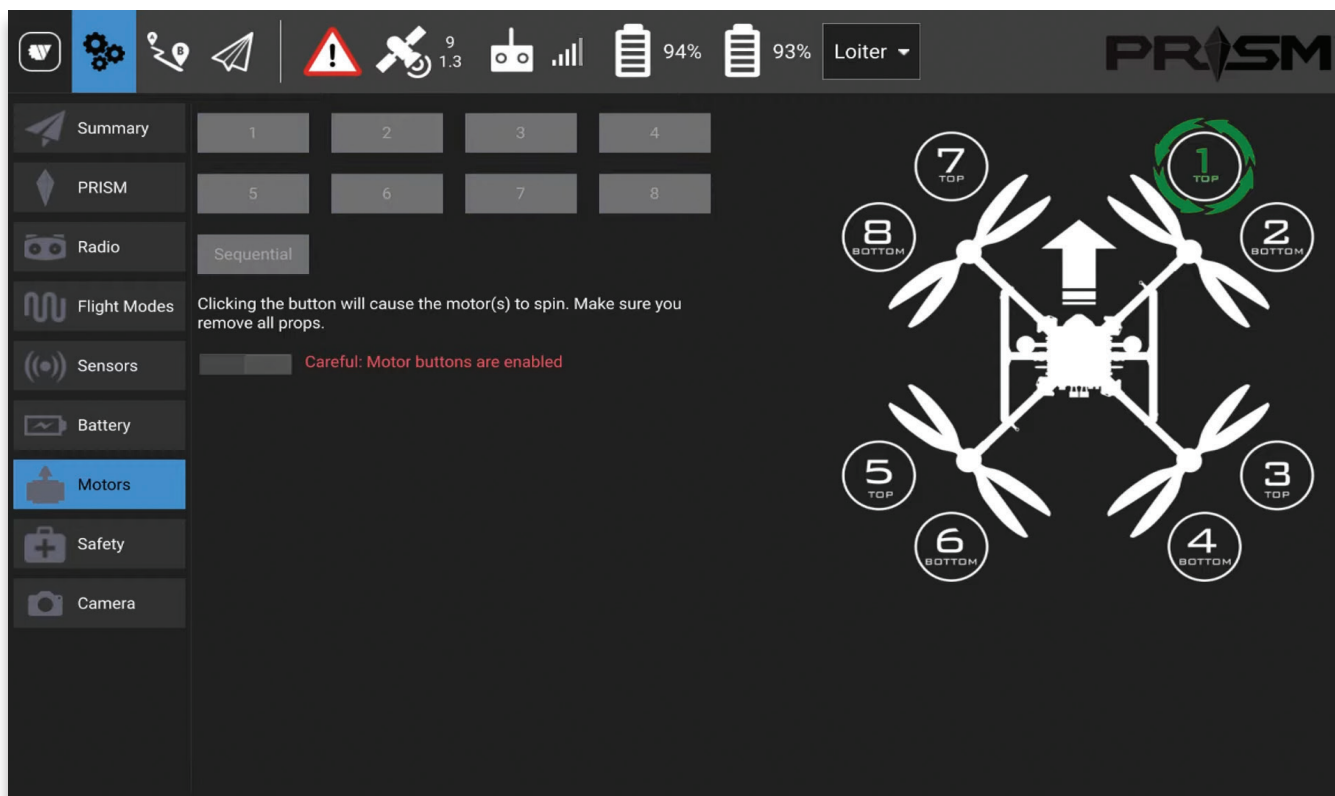
Users may use this screen to test motors and propulsion configurations by first ensuring the propellers are removed, then swiping the toggle switch to enable motor buttons. Users may power up motors individually for testing purposes once the buttons are enabled. This is a great tool for ensuring that the motor and propeller direction are correct. This may be useful after a propeller change.



**WARNING:**

**During this Motor Test sequence, the motors will be live and the propellers will spin. The RPM will spin quite slowly, but it is always imperative that all persons and property are clear from any spinning propeller during the Motor Test procedure.**

■ **Figure 33: PRISM MOTOR TESTING SCREEN**



## (viii) SAFETY

The Safety menu controls failsafe actions and triggers, such as critical battery voltage or mAh thresholds, as well as geofencing behavior and RTL altitude.

### **SETTING THE LOW ACTION AND CRITICAL ACTION SETTINGS:**

PRISM is shipped from the factory with Battery 1 and Battery 2 low voltage protections set quite conservatively. This will ensure that an aircraft will return to home when the voltage gets too low.

Users may wish to adjust the Low Action and Critical Action characteristics for their aircraft based on the battery size and payload that is installed. It is highly recommended that these are set conservatively!

### **HOW TO SET THE OPTIMAL LOW ACTION AND CRITICAL ACTION SETTINGS FOR YOUR PAYLOAD AND BATTERY CAPACITY:**

Due to a wide range of reasons, the aircraft Low Battery voltage warning value may vary. If an aircraft is using older batteries with more cycles on them, those batteries will naturally hover at a low voltage. In addition, if a heavy payload is installed on the aircraft, the voltage will naturally be lower in a hover than if it did not have a payload. For these reasons, battery voltage cannot be fully trusted to provide the pilot with fully correct situational awareness.

For this reason, the battery capacity (Milliamp- Hours/mAh) is also monitored to ensure the full health of the pack is known at a given time.

With this information, operators may choose to set their Low Action and Critical Action in a way in which leaves the most amount of time in the air, while ensuring that the the vehicle will return to home safely in an event that the Low Action or Critical Action is triggered in flight.

### **TUNING LOW ACTION & CRITICAL ACTION TO OPTIMAL VALUES:**

- Install the heaviest payload that your operation would ever require
- Install flight batteries that have the highest number of cycles on them
- Fly the aircraft and monitor the mAh consumed of both Battery 1 & Battery 2
- When the aircraft has consumed 70% of its battery capacity, note the voltage.
- When the aircraft has consumed 80% of its battery capacity, note the voltage.



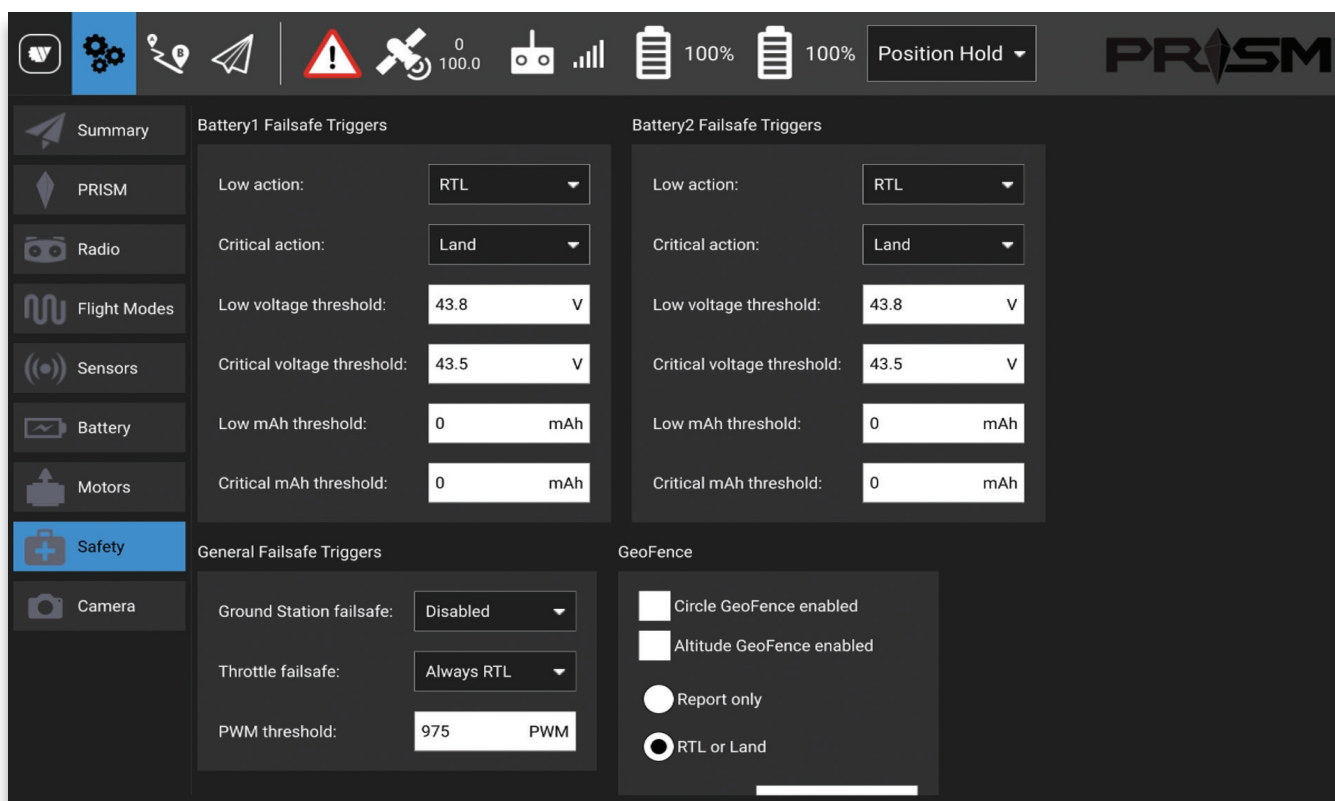
The voltage that the aircraft was at when 70% of its battery capacity left may be entered into Battery 1 & Battery 2 Low Action. The voltage that the aircraft was at when 80% of its battery capacity left may be entered into Battery 1 & Battery 2 Critical Action.

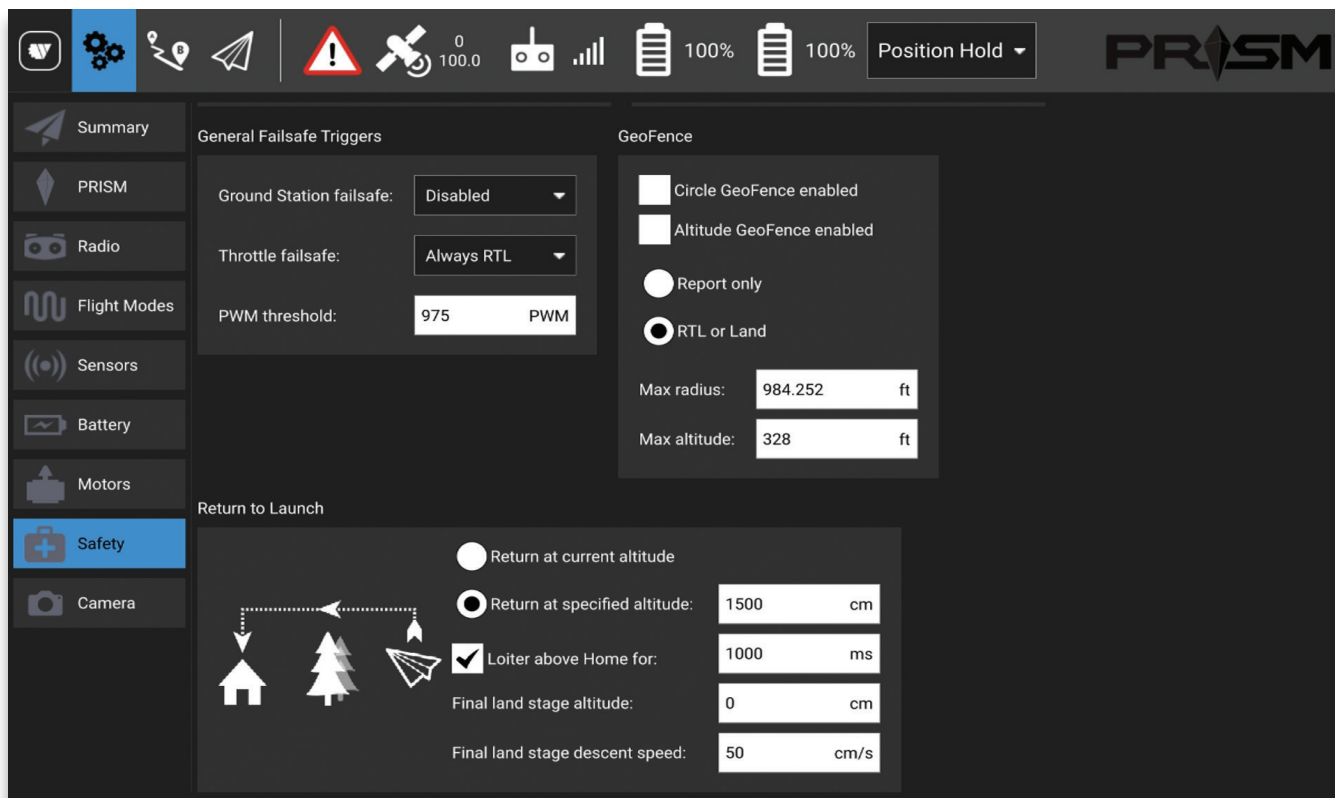
By following these steps, it will ensure that the vehicle is configured in such a way that it can safely land in an event that the battery gets too low during flight.

The factory set values will initiate a RTL at 43.8V and will land the aircraft at 43.5V. At any given time, the RTL may be overridden by the user by simply changing flight modes into ALTHOLD.

*Advanced users may choose to perform low voltage actions by capacity (mAh) instead of voltage*

■ **Figure 34 & 35: SAFETY PARAMETERS SCREENS**





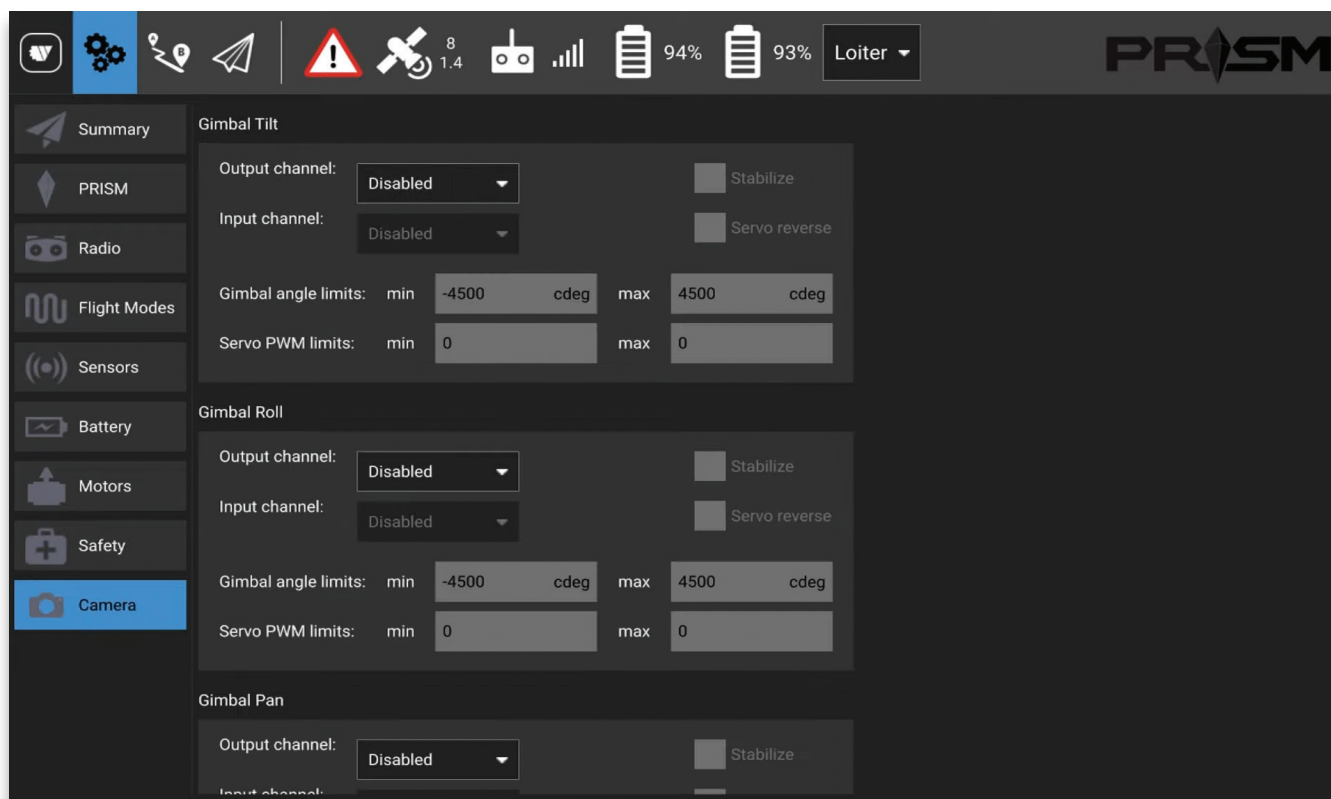
**(xi) CAMERA**

This screen will be used to configure a payload gimbal and channels for mounted camera payloads.





■ **Figure 36: CAMERA INTEGRATION SETTINGS**



### 7.12.3 AUTOMATED MISSION FLIGHT SETUP

WattsQGC supports automated flight operations including area surveys, corridor scanning, and structure scans. It also supports the import and export of mission-planning files such as KMLs using the USB port on the EchoSky Mobile.

Users may define the aircraft's behavior at and between waypoints, including orientation, altitude, speed of travel, and end-of-mission behavior. Once the mission parameters are defined the user may tap "Upload Required" in the upper-right of the UI, and the progress of the mission upload to the aircraft will be indicated by a green status bar.

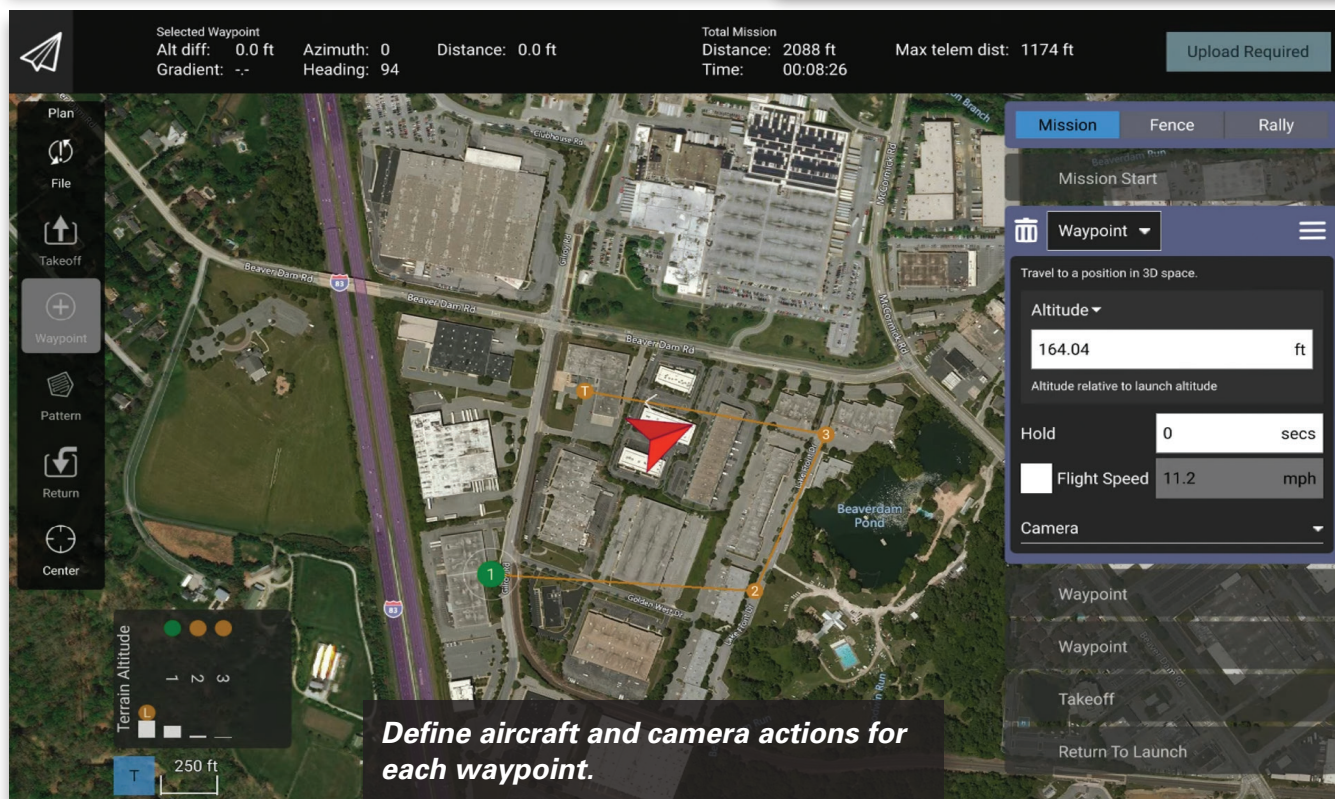
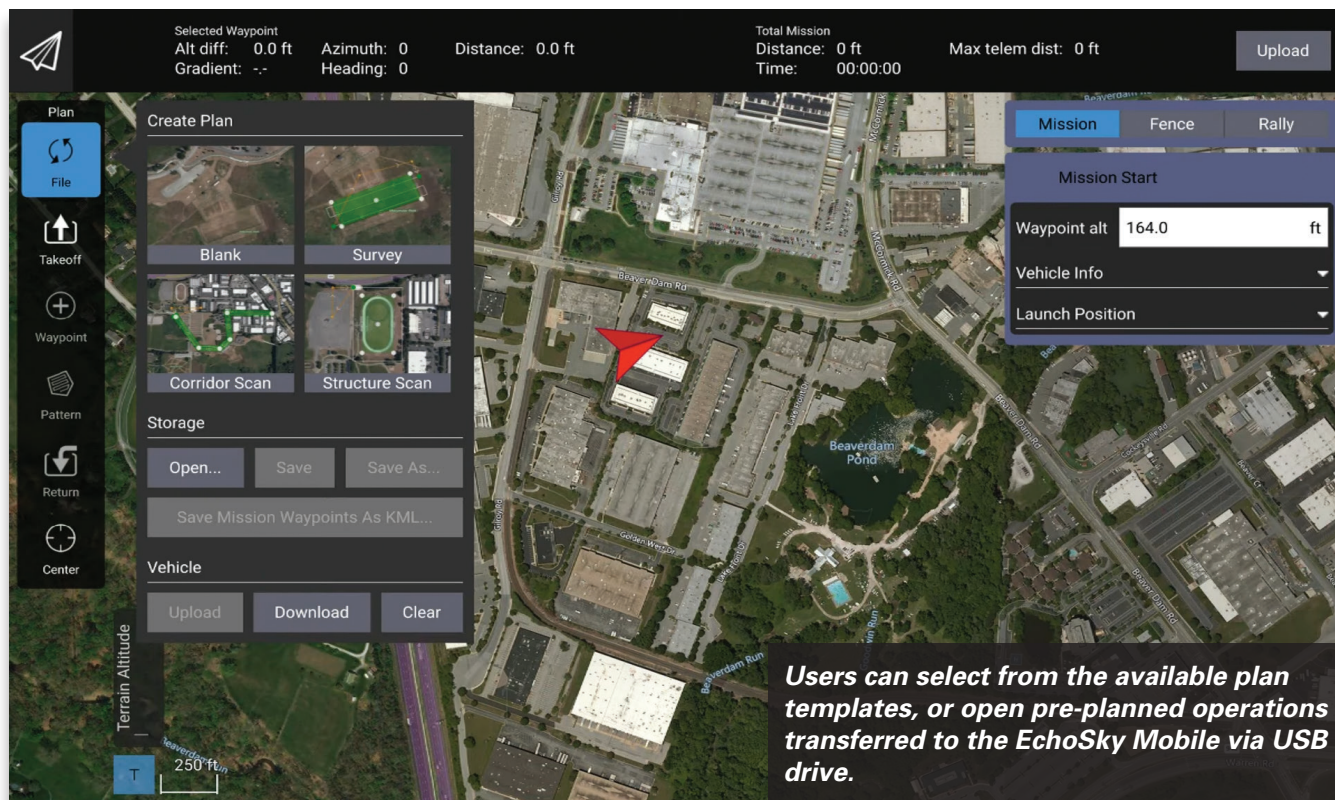
Upon successful upload, the user may navigate to the main Fly screen by tapping the Fly button in the upper left. A "Start Mission" slider will appear at the bottom of the main telemetry screen.

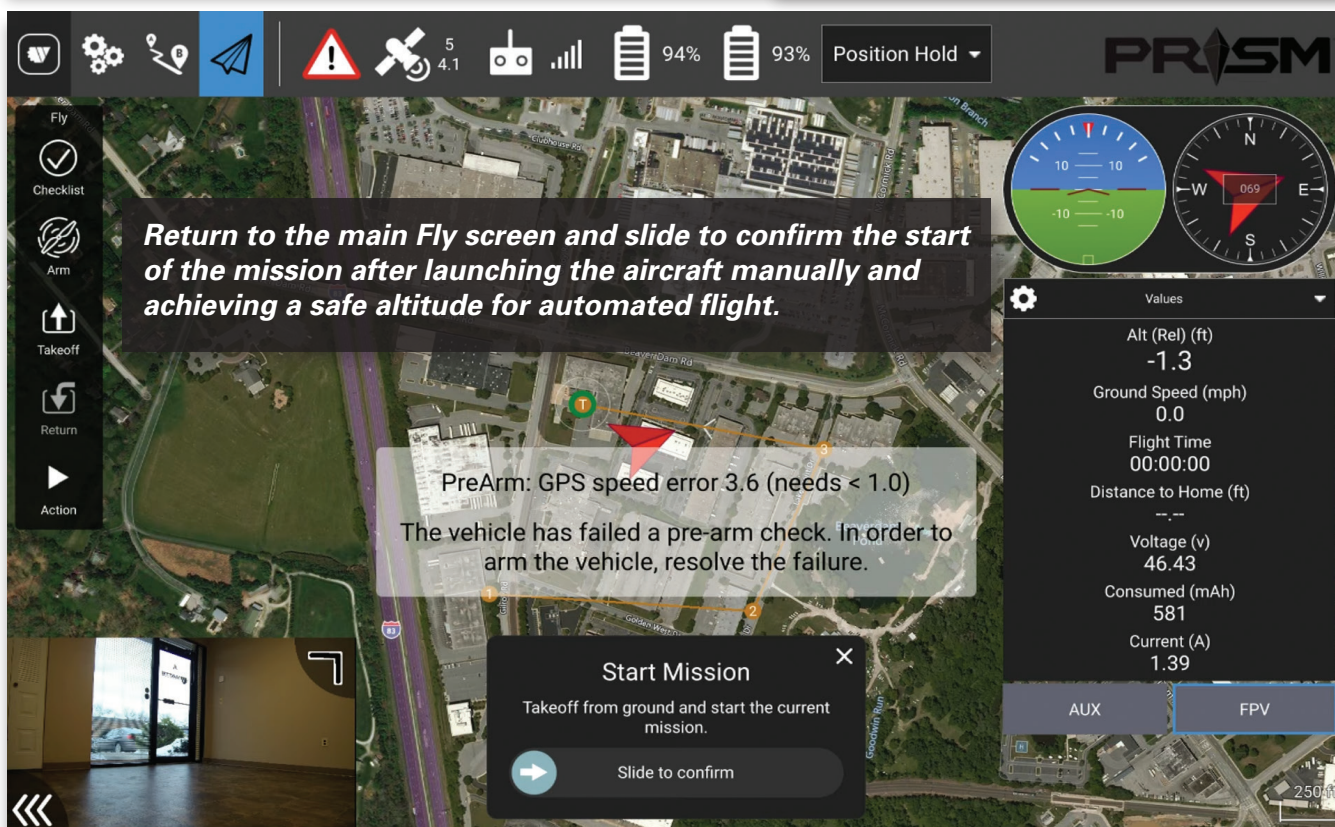
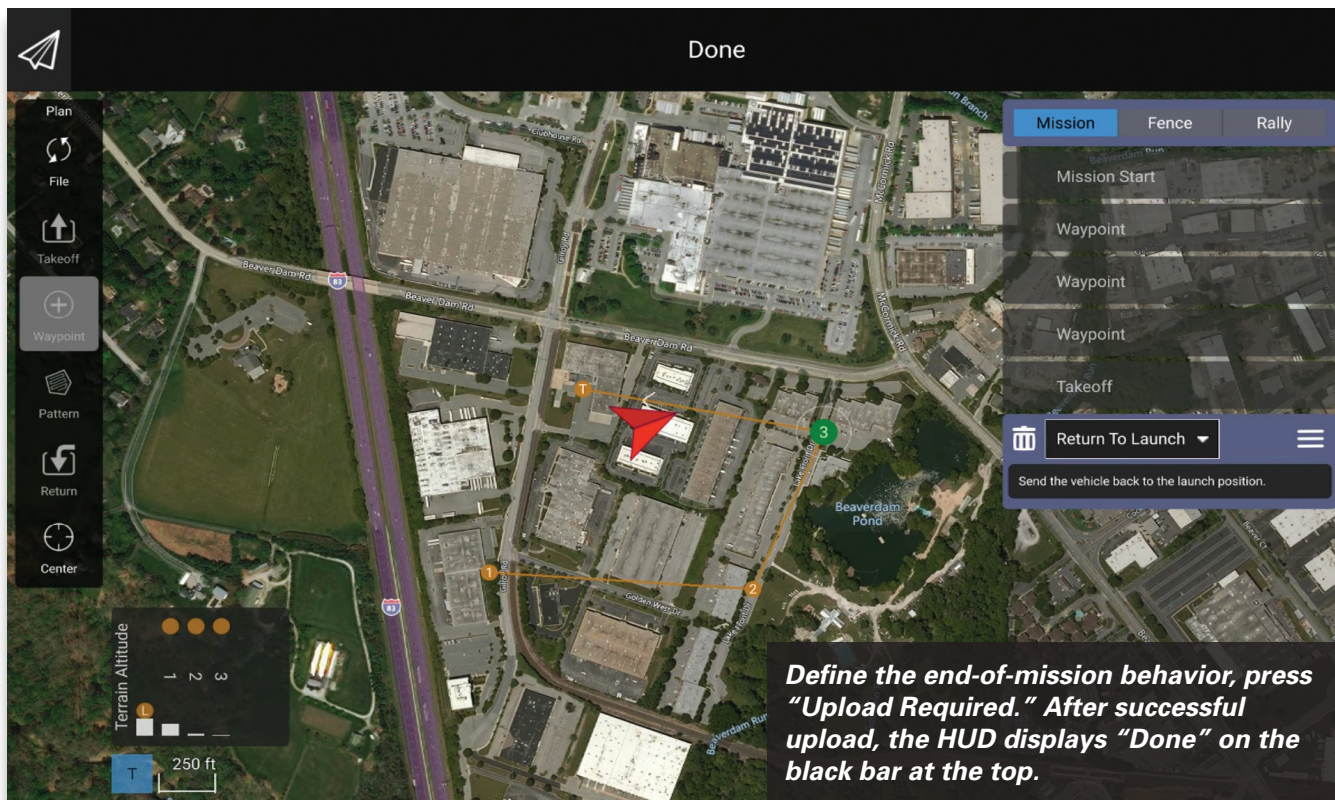
#### **NOTE:**

**Pilots should always manually launch PRISM aircraft in Position Hold or Stabilize Mode, then switch the flight mode to Auto once clear of obstacles and ready to start the mission.**



■ **Figure 37-40: PRISM AUTOMATED FLIGHT SETUP SCREENS**





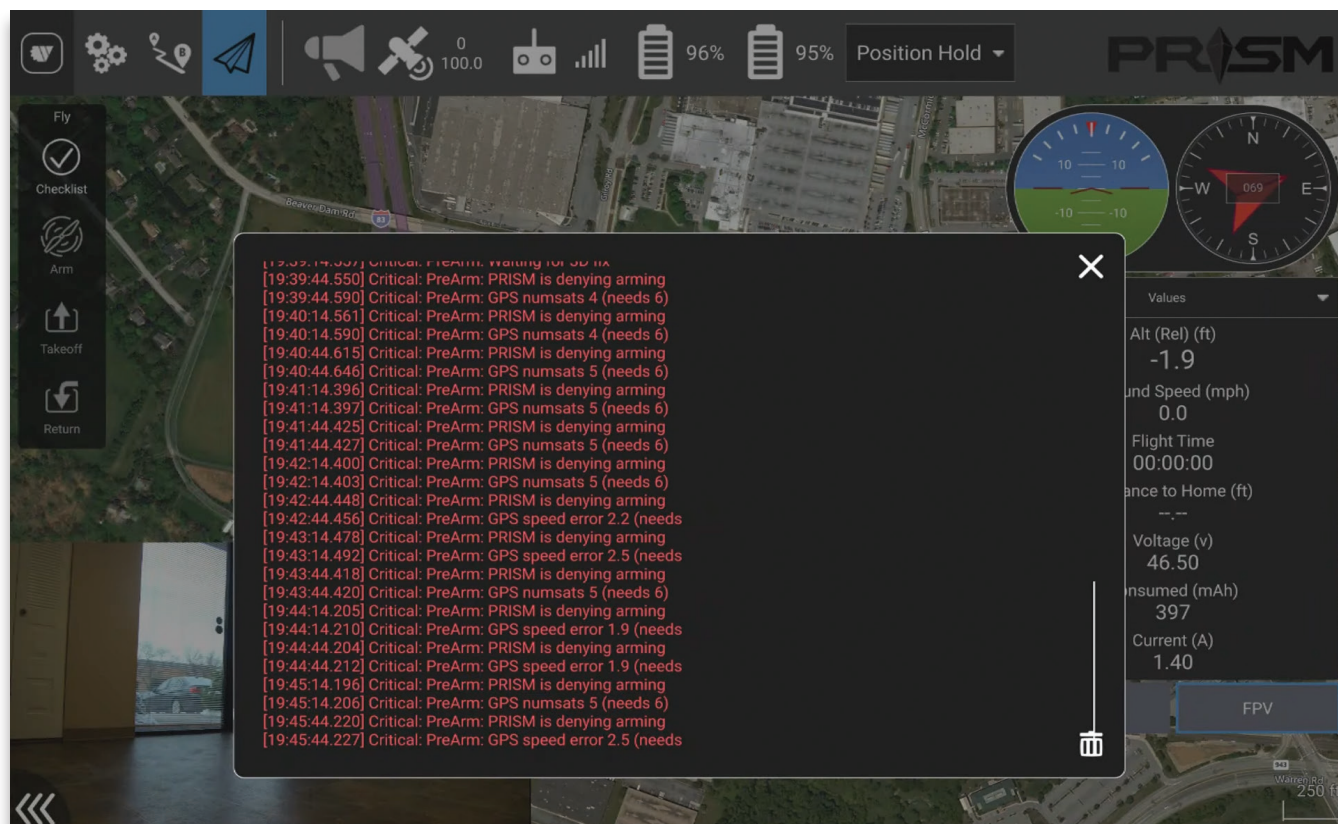
## 7.12.4 FLIGHT AND TELEMETRY DATA

The main Fly screen of the WattsQGC app displays real-time telemetry from the RPA in several locations around the HUD. The numbers in parentheses in the following section refer to the numbered labels in Figure 12 above.

### (i) MAVLINK SYSTEM NOTIFICATIONS AND WARNINGS

Tapping on this icon (5) shows any system warnings produced by the MAVLink protocol during system startup and runtime.

#### ■ Figure 41: MAVLINK NOTIFICATIONS

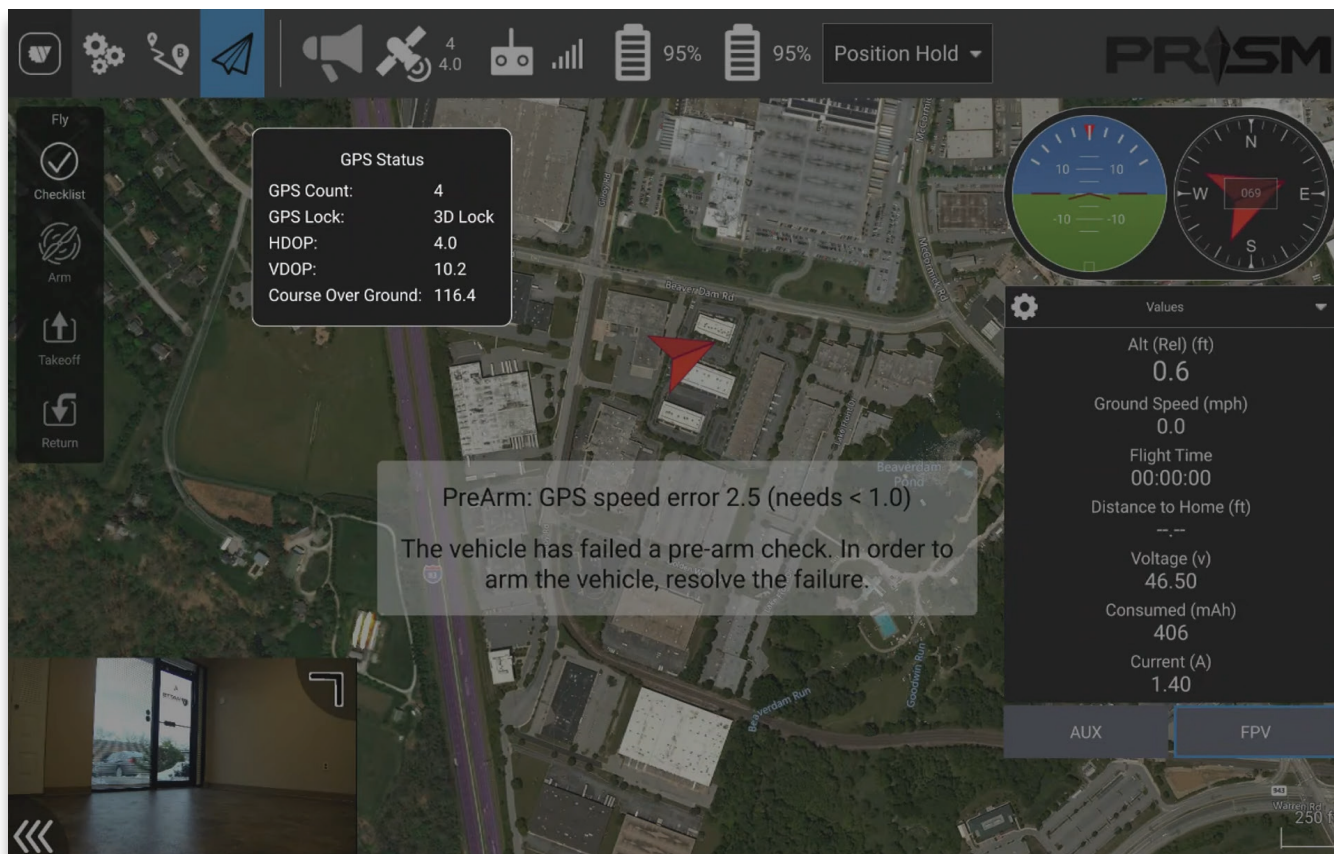


### (ii) GPS SATELLITE STATUS

Tapping this icon (6) displays the number of GPS satellites received by the RPA's GPS antennas, the type of GPS lock in effect, the vertical and horizontal dilution of precision, and the RPA's course over ground, or direction of travel (this is not the same as the RPA's magnetic heading, since the RPA may have its nose pointed in one direction while moving in another).



■ **Figure 42: GPS SATELLITE STATUS**



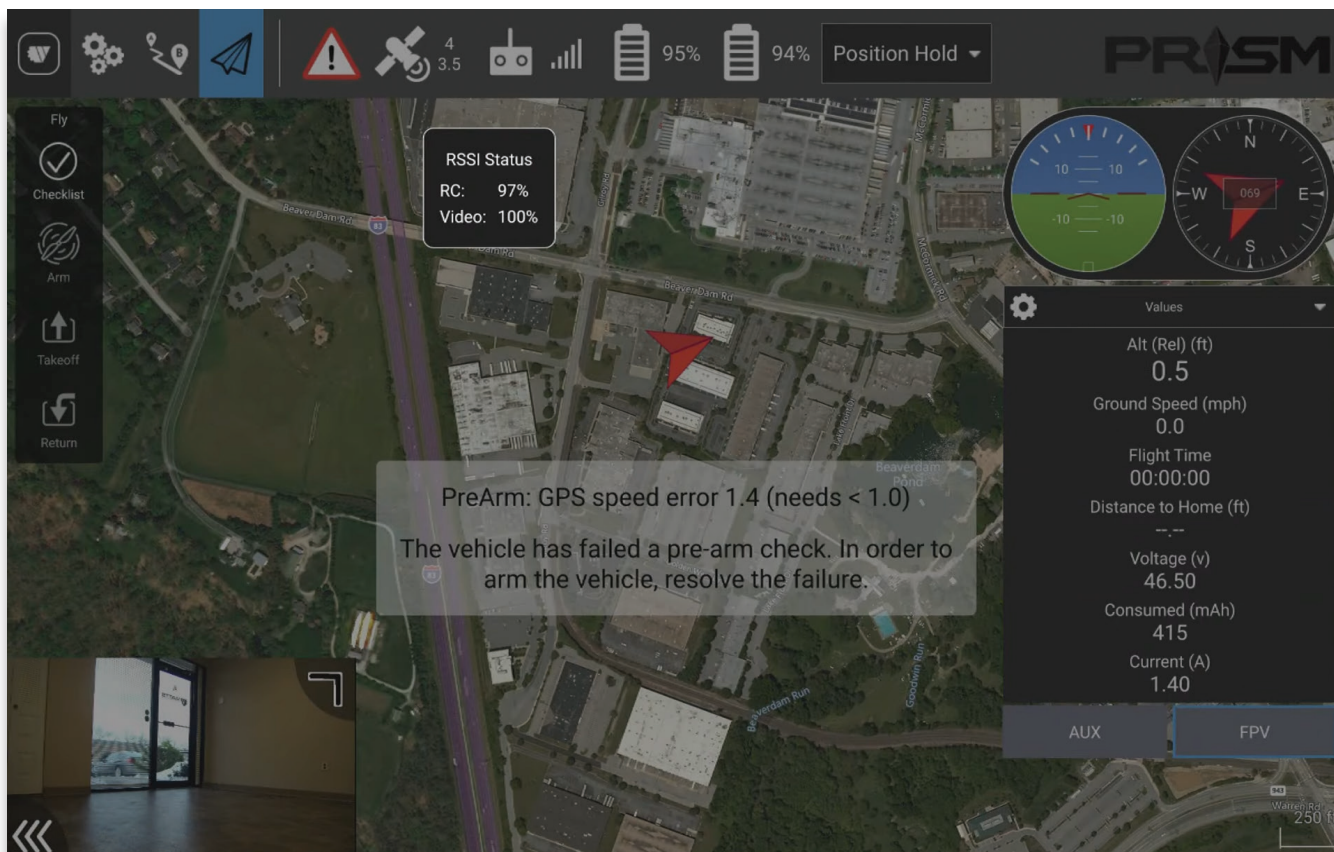
### (iii) RSSI FOR CONTROL/VIDEO LINK

This icon (7) displays the Received Signal Strength Indicator for the C2 and video downlink connection with the RPA. Tapping on the icon will show the strength of the connection as a percentage of overall connection health. A low RSSI value will indicate that:

- The aircraft is flying too far away from the pilot.
- Radio Line of Sight is obstructed.
- There is external interference/ noise on the 2.4Ghz band.
- There is a malfunction of the antennas or transmission system.



■ Figure 43: C2 RSSI INFORMATION

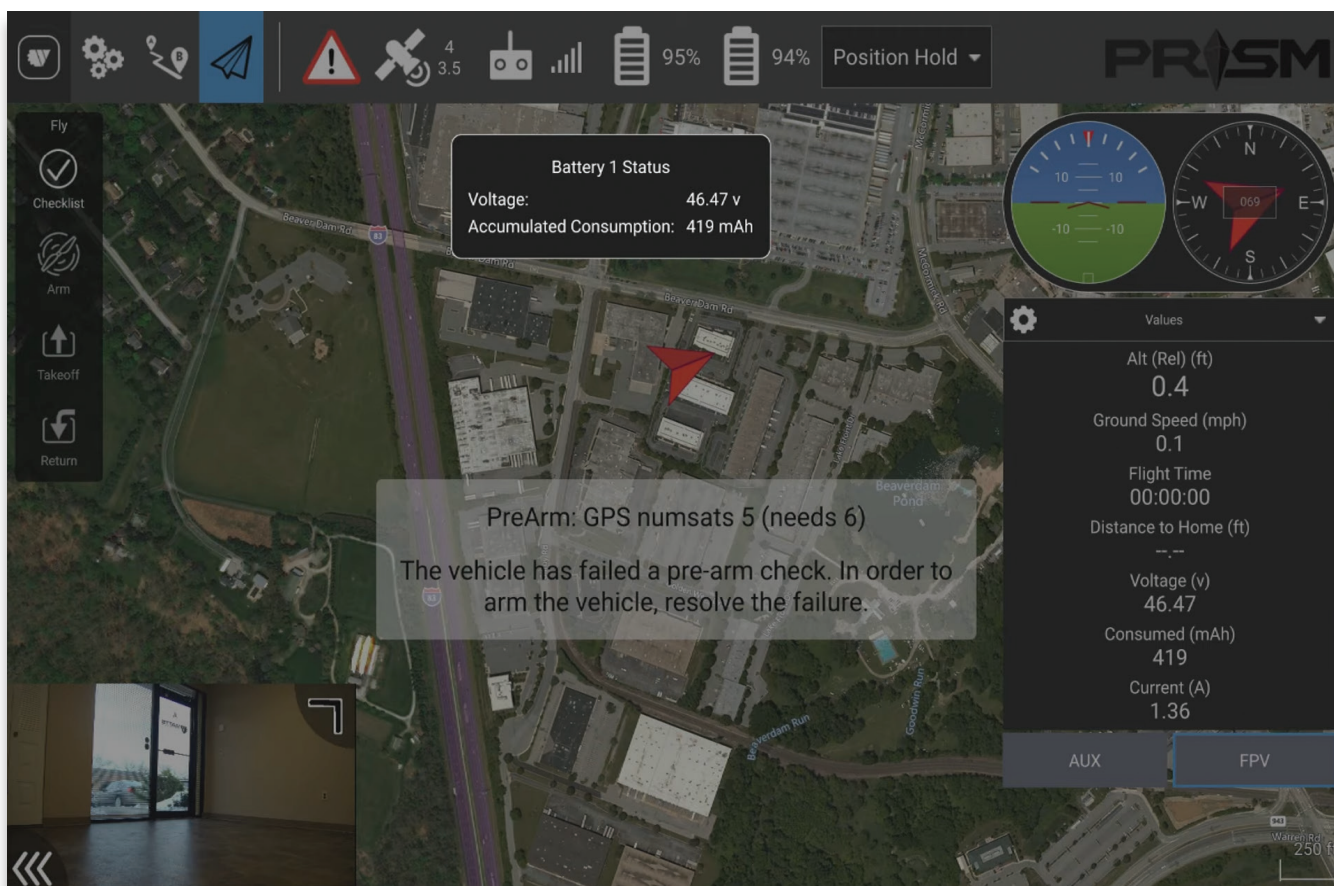


#### (iv) BATTERY mAh REMAINING

The two battery icons (8) show the remaining mAh for each battery as a percentage. Tapping on either icon shows the voltage and detailed mAh consumption information for the respective battery.



■ Figure 44: BATTERY STATUS

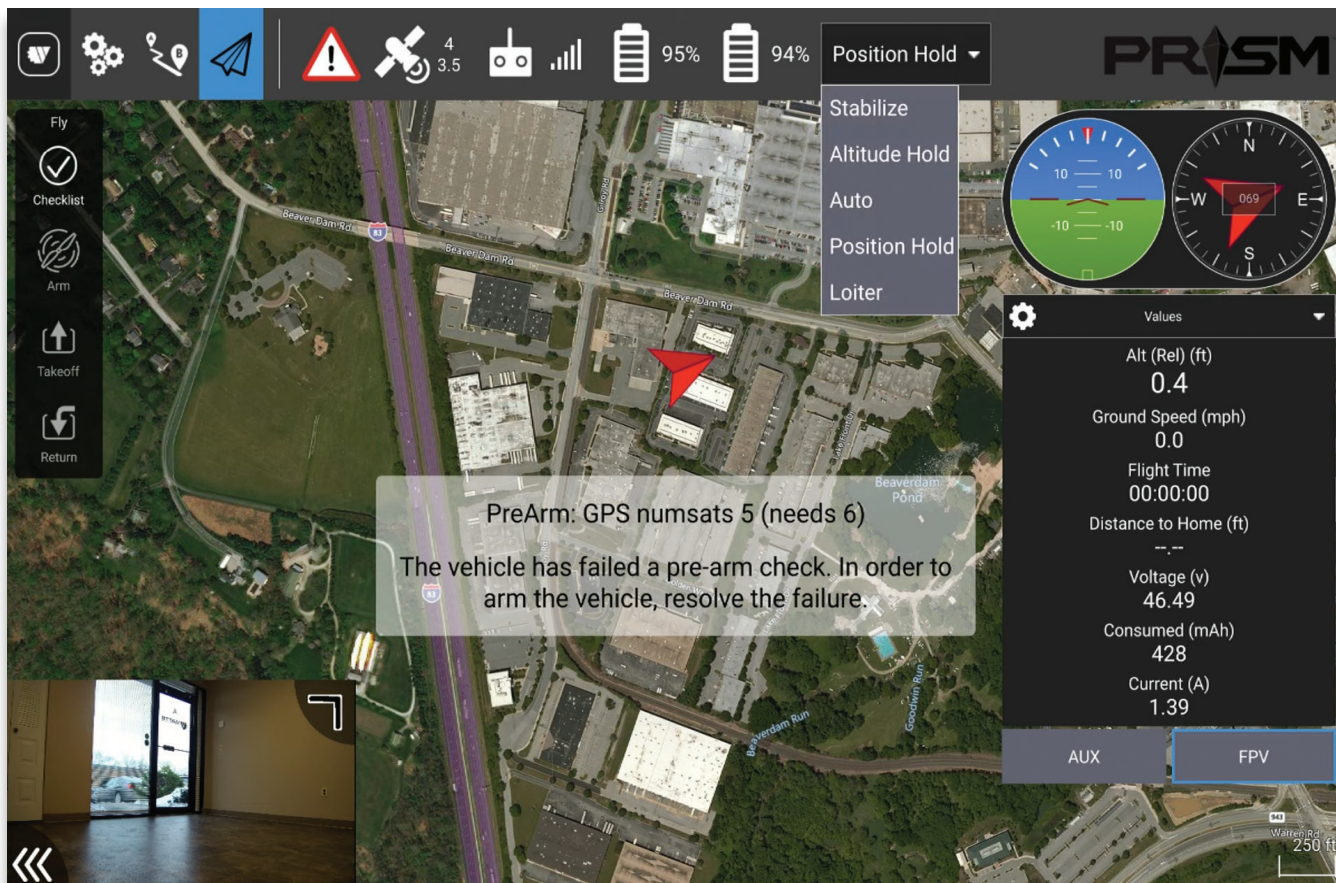


#### (iv) FLIGHT MODE

This displays the active flight mode. Tapping on the flight mode (9) produces a drop-down list of the available flight modes and allows the user to change modes from the main Fly screen.



■ **Figure 45: FLIGHT MODE INDICATOR/SELECTOR**



**(vi) ARTIFICIAL HORIZON & HEADING INDICATOR**

These side-by-side icons (10) show the aircraft’s orientation relative to the level, and the magnetic direction its nose is pointed. This data is derived from the on-board IMU and magnetometer.

**(vii) REAL-TIME TELEMETRY VALUES**

The box at the right of the HUD (11) displays a number of user-customizable values. By default, the values displayed are the Altitude above the launch point, ground speed, total flight time, distance to the home point in feet, system voltage, consumed mAh, and current in Amperage.

By tapping on the gear icon in the upper left of this box, the user may customize which system values are displayed in this section.

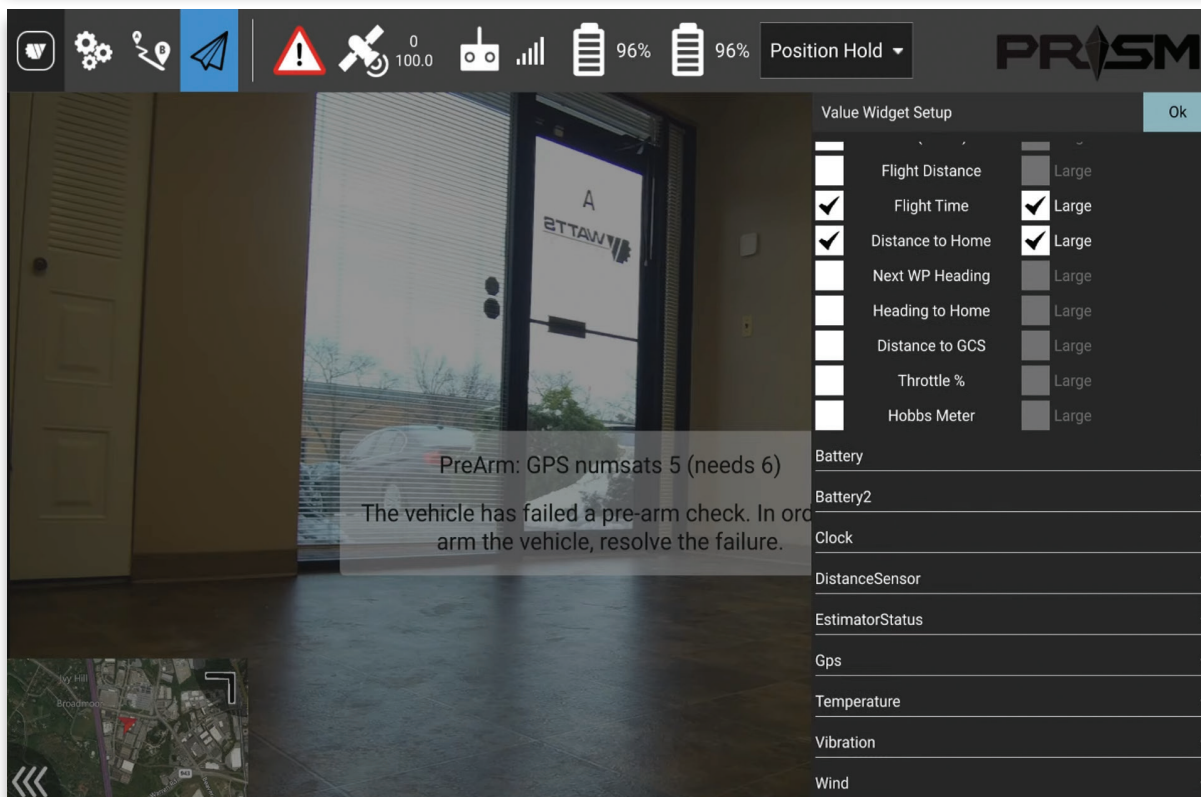
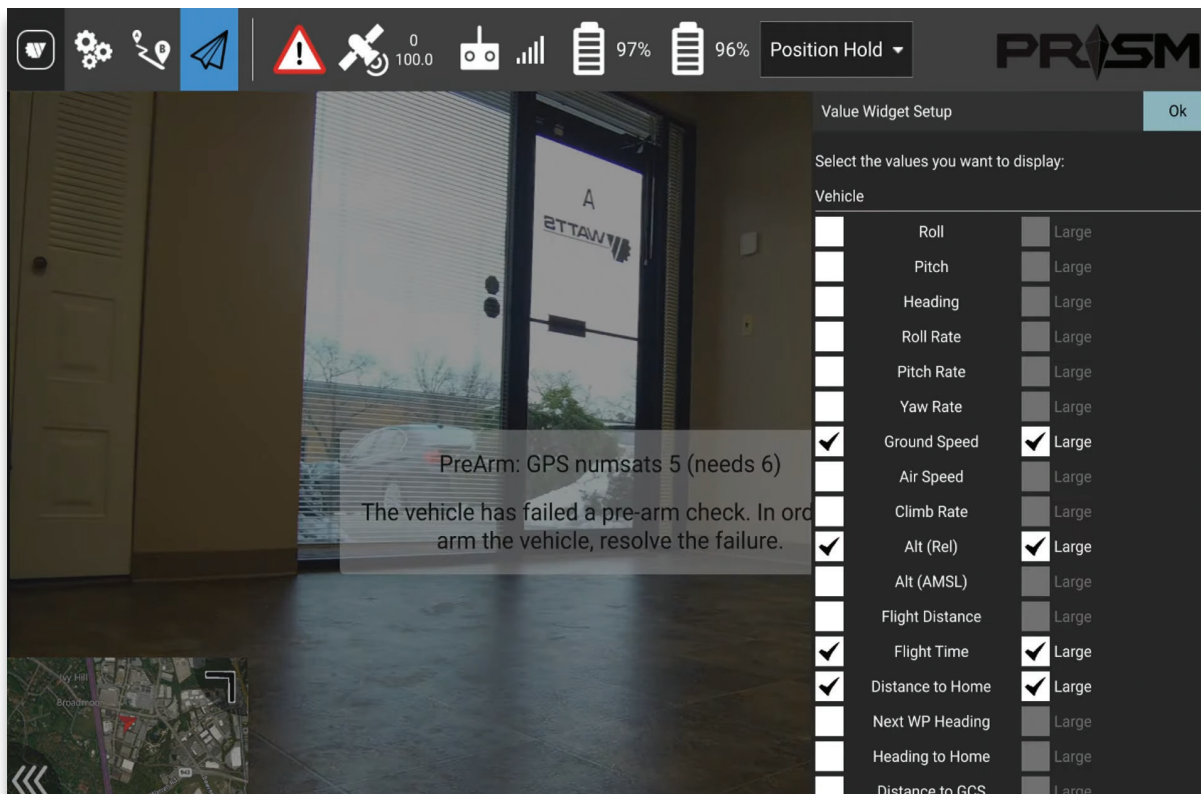
**NOTE:**

The battery Consumed value (mAh) and Current (A) values are for the #1 battery only. This is the battery connector that is mounted on the left side of the aircraft.





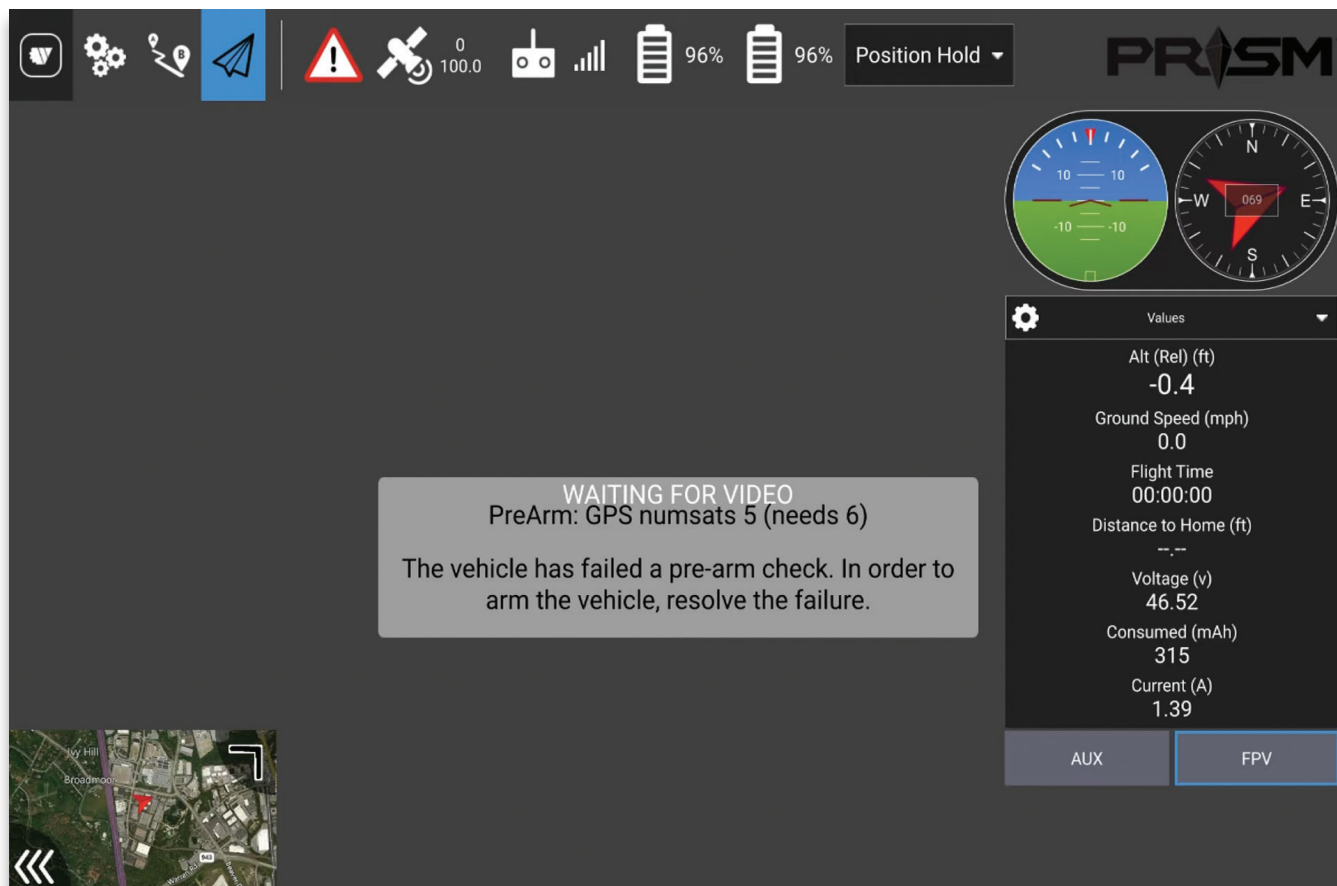
■ Figure 46 & 47: USER-SELECTABLE TELEMETRY VALUES FOR HUD



### (viii) CAMERA INPUT SOURCE SELECTOR

The user may select between the FPV or AUX video input feeds by tapping the corresponding button in this section (12). If no video source is connected to the HDMI Auxiliary input, a gray screen with the words “WAITING FOR VIDEO” is displayed.

■ **Figure 48: NO AUX VIDEO SOURCE**



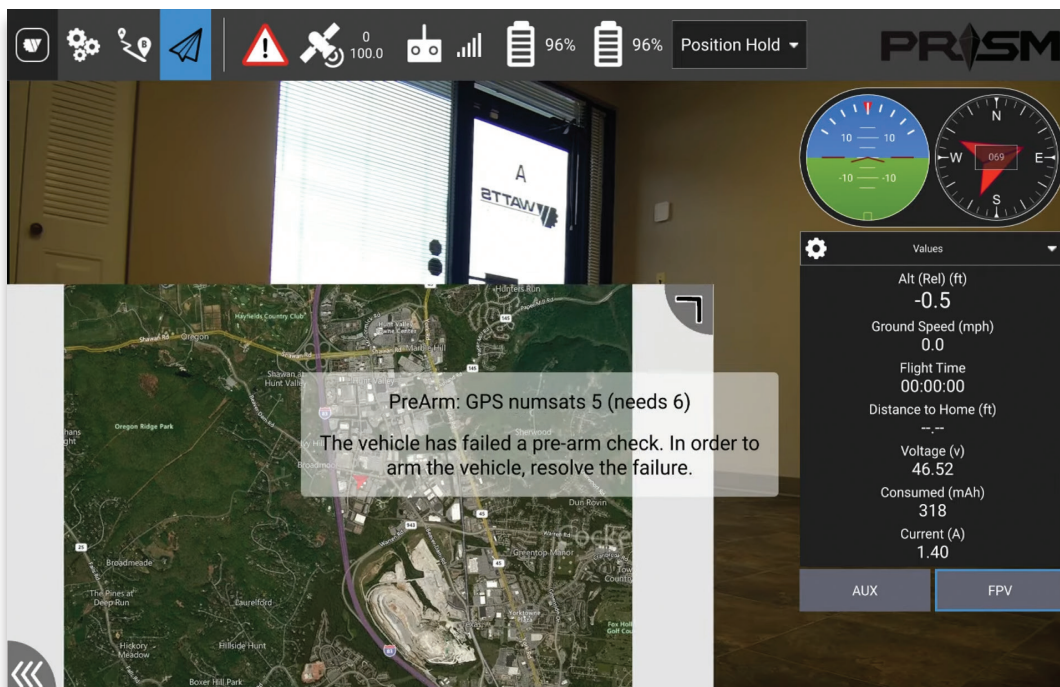
### 7.12.5 PICTURE-IN-PICTURE

By default, the WattsQGC displays the FPV video feed on the main Fly screen with a mapping inset in the lower-left corner (Number 13 in Figure 12). Users may minimize the main feed and make the full-screen by tapping on the inset.

Users may resize the picture-in-picture inset by dragging the upper-right corner until the inset reaches the desired size. They may hide the inset entirely by tapping the three left-pointing chevrons in the lower-left corner.



■ **Figure 49: PICTURE-IN-PICTURE RESIZING**



## 7.12.6 ARMING AND LAUNCHING COMMANDS

WattsQGC enables the user to prep, arm, and launch PRISM using the application interface. The numbers in parentheses in the following section refer to the numbered labels in Figure 12 above.

### (i) PRE-FLIGHT CHECKLIST

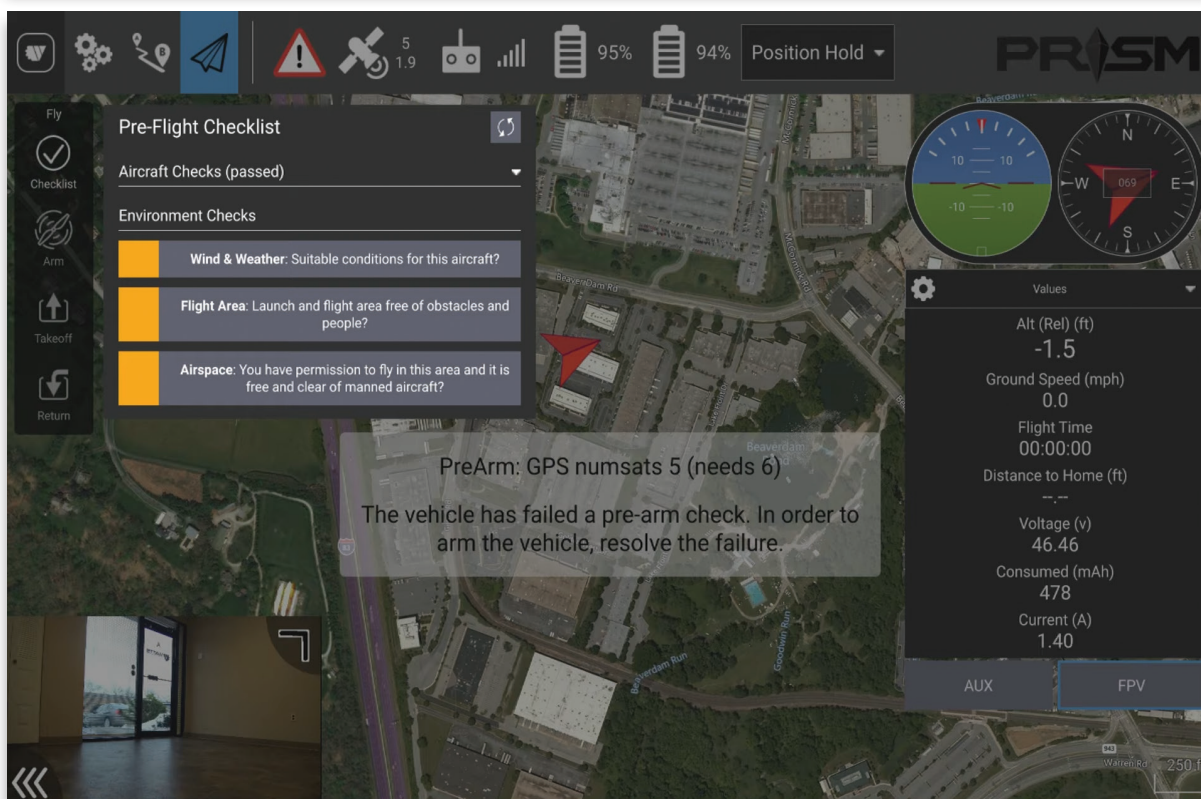
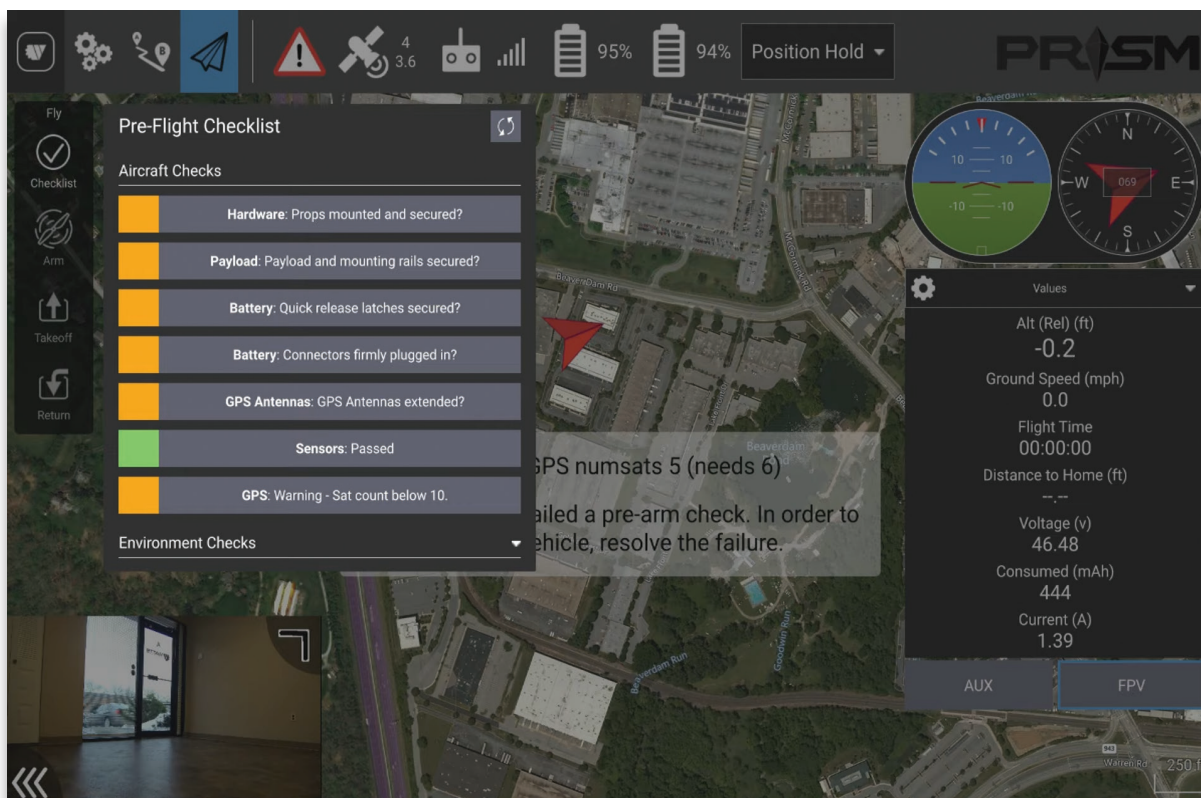
For safety reasons, WattsQGC requires the user to acknowledge a series of prompts before allowing the motors to arm each time. The user must complete the Pre-Flight Checklist (17) composed of Aircraft Checks and Environment Checks.

Aircraft Checks prompt the user to verify that the propellers are mounted and secure, the payload is securely in place, the battery latches are fully engaged, the power connectors are flush, and that the GPS antennas are extended and receiving sufficient GPS signal for the selected flight mode (a minimum of 10 satellites to launch in Position Hold mode). The system also runs an automated check of the aircraft sensors and displays a green status bar if the check passes.

Environmental Checks prompt the user to verify that the wind and weather conditions are below the legal and practical operating thresholds for PRISM, that the flight area is clear of obstacles and people, and that the operator is authorized for the airspace and able to operate without interfering with manned aircraft operations.



■ Figure 50 & 51: WATTSQGC PRE-FLIGHT CHECKLIST



## (ii) ARM

The Arm icon (16) will only activate if the pre-flight checklist has been completed and there are no outstanding system alerts.

The aircraft may be armed in one of two ways:

- Tap the Arm icon, then swipe a slider to confirm.
- Pull the throttle stick all the way down and to the right, and hold it in position until the system arms

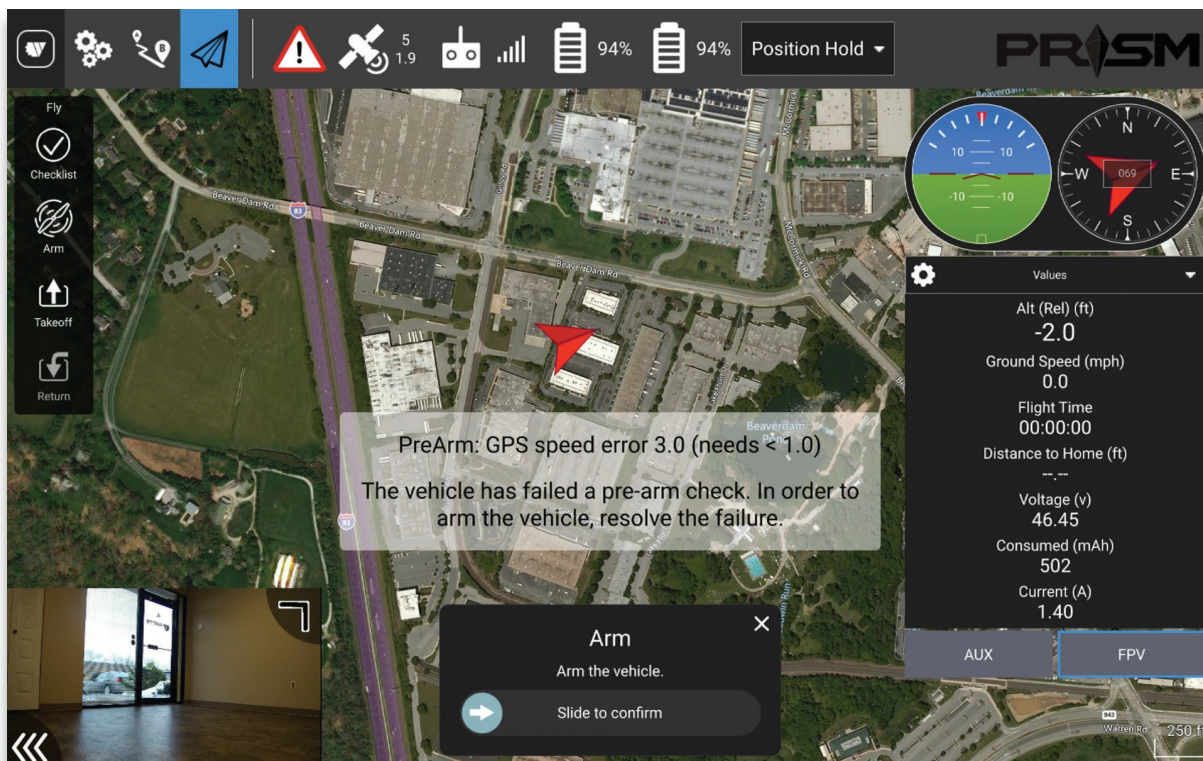
Once the system arms, the RPS will audibly say "ARMED". In addition, the word "ARMED" will be displayed on the WattsQGC Application. At this point, the motors will be live and flight can begin.



### WARNING:

If arming PRISM using the app while in STABILIZE mode, ensure the throttle (left stick) is pulled all the way down before confirming. Failing to hold the throttle down will cause the aircraft to leap into the air once armed.

## ■ Figure 52: SWIPE TO CONFIRM ARMING



### (iii) DISARM

The Disarm icon (16) will appear once the vehicle has landed and the vehicle is still armed.

The aircraft may be disarmed in one of two ways:

- Tap the Disarm icon, then swipe a slider to confirm.
- Pull the throttle stick all the way down and to the left, and hold it in position until the system disarms

Once the system disarms, the RPS will audibly say “DISARMED”. In addition, the word “DISARMED” will be displayed on the WattsQGC Application. At this point, the motors will come to a stop and it is safe to approach the vehicle.

### (iv) TAKEOFF

Once PRISM motors are armed, the operator may initiate an automated launch by tapping on the Takeoff icon (15). **This is not recommended at this time for heavier lift configurations.**

### (v) RETURN

Tapping on the Return icon (14) will initiate a return-to-land sequence wherein the aircraft executes the RTL failsafe.

## 7.12.7 SYSTEM WARNING TEXT

Outstanding system warnings which prevent the safe operation of PRISM RPA will display in a text box superimposed over the main Fly screen. In area 18 of Figure 12 above, the Warning Text indicates that the system has failed a pre-arm check because there are not enough satellites visible to the GPS antennas to launch while in Position Hold mode, which requires a minimum of 10 visible satellites.

## 7.12.8 ADVANCED USER MODE

The WattsQGC application has been custom-built for PRISM RPA and its capabilities. The application was built from the framework of the powerful QGroundControl mission-planning platform, which contains many more customizable settings and parameters than are included in the WattsQGC standard application.

Watts Innovations recognizes that PRISM users may need or desire to adjust settings not accessible through the loadout interface. As such, WI has provided access to an Advanced User mode.





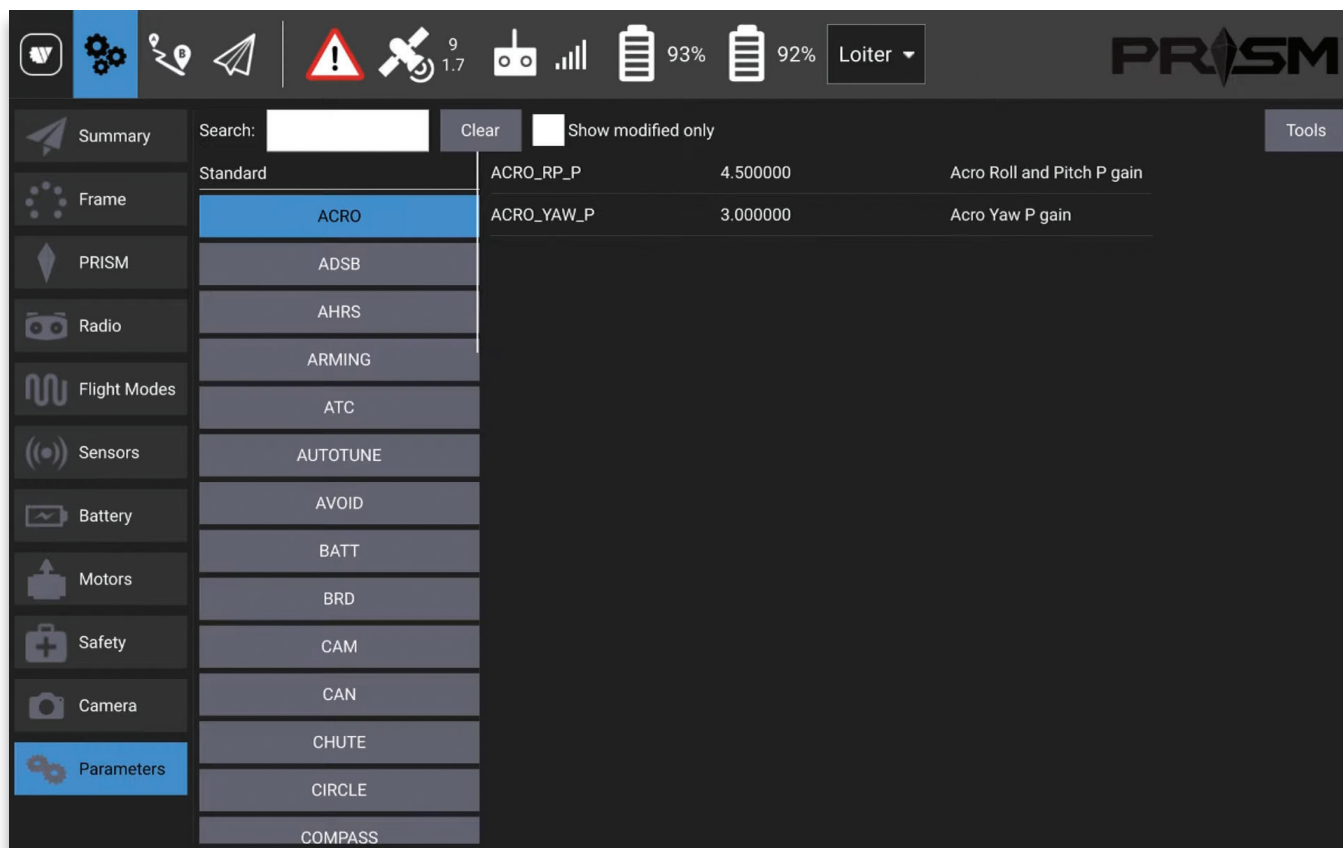
**WARNING:**

Damages to PRISM or its components attributable to changes to parameters accessed in Advanced User Mode are not covered by warranty. Access Advanced User Mode and modify the factory-default WattsQGC application at your own risk.

Advanced User Mode is accessed from the main Fly screen by tapping the Fly icon (Number 4 in Figure 12 above) FIVE times. Once parameters have been adjusted the user may return to the standard WattsQGC interface by tapping the same icon five times again.

The main difference between Basic and Advanced user mode is the fact that the user has access to the full PARAMETER menu. This allows the setting of every parameter within the flight controller, from setting up additional channels for payloads and sensors, all the way to modifying battery calibration values, PID gains, and how the aircraft handles.

■ **Figure 53: ADVANCED USER MODE OPTIONS**



## 7.12.9 UPDATING WATTSQGC

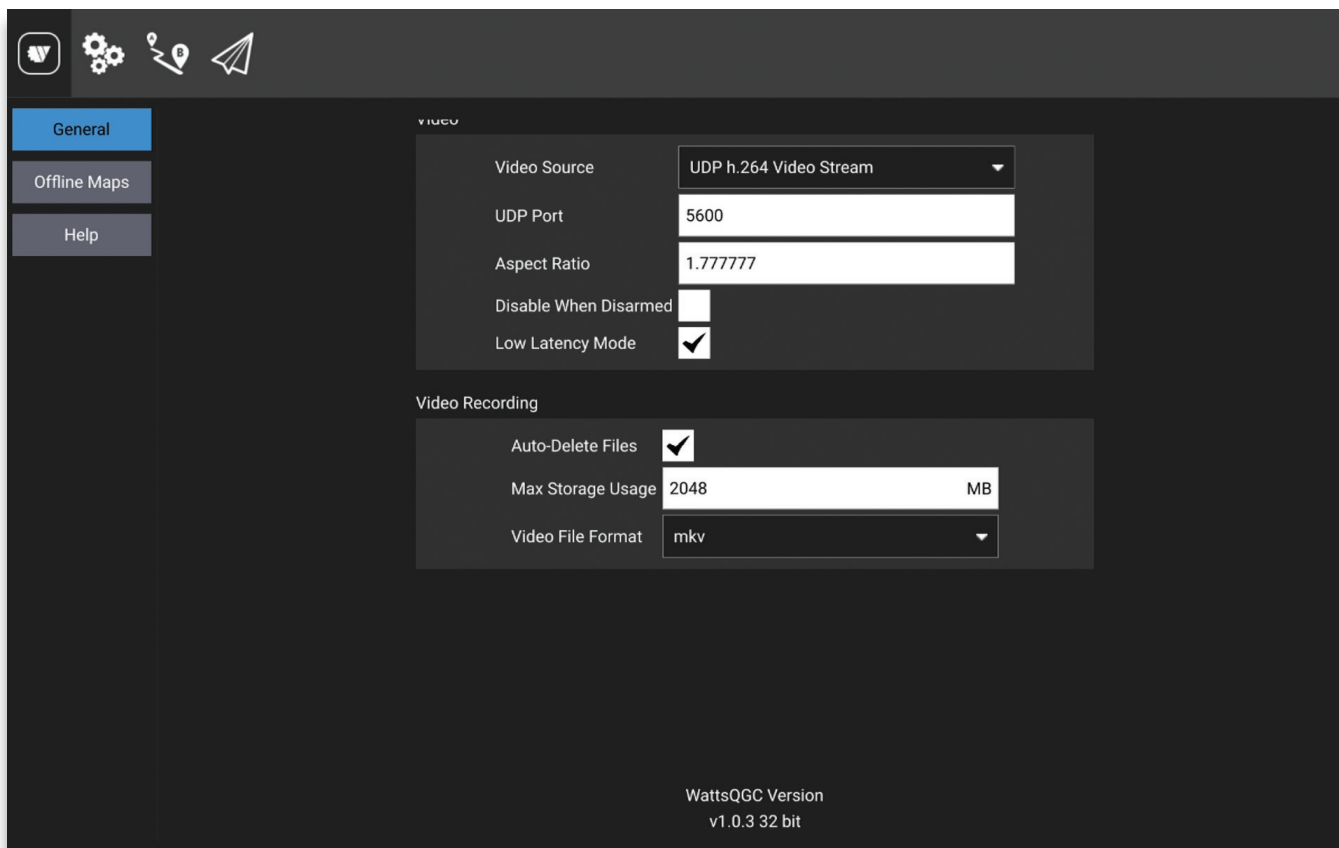
Watts Innovations will frequently release new versions of the WattsQGC Application for the EchoSky Mobile handset. These updates will include new feature implementations, improvements and bug fixes. It is highly recommended that users continually update both WattsQGC as well as the onboard PRISM firmware to ensure optimal performance and the best user experience possible.

Updating the WattsQGC app will not cause any information such as cached maps, automated missions, or telemetry data to be erased.

Upon opening the WattsQGC application, a pop-up will appear asking the operator if he would like to update the application. Simply press “YES” and the application will begin to update.

### NOTE:

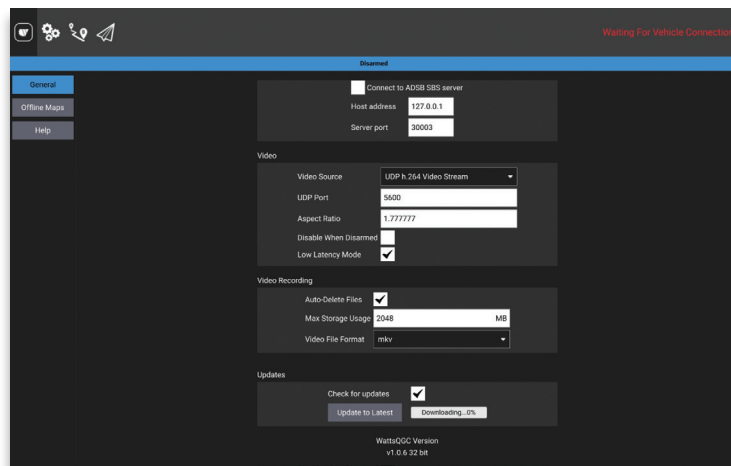
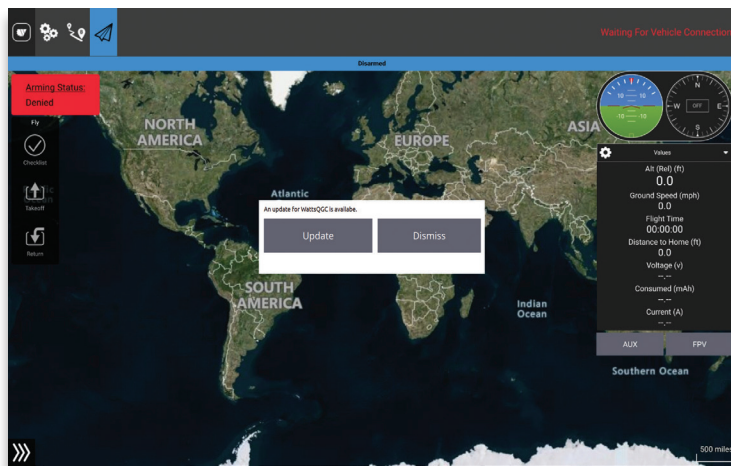
The EchoSky Mobile handset must be connected to a WiFi network in order to update.



**You may see the current version of the WattsQGC App by accessing the General Settings tab of the App Settings**







*Automatic Update - Updating from general settings page*

### 7.13 GROUND SUPPORT

PRISM RPAS requires a ground support infrastructure to ensure safe and reliable operations. The following list is recommended by the manufacturer as a minimum equipment list to be used prior to or during flight operations.

<b>FIRST AID KIT</b>
<b>FIRE EXTINGUISHER</b>
<b>RPAS FLIGHT MANUAL</b>
<b>ANEMOMETER</b>
<b>BATTERY TESTER</b>
<b>PORTABLE SCALE</b>
<b>FIELD TOOL KIT</b>
<b>PORTABLE LAUNCH/LANDING PAD</b>
<b>CONES FOR DEMARCATING OPERATION AREA</b>



## CHAPTER 8: EMERGENCY PROCEDURES

### 8.1 INTRODUCTION

This section outlines the procedures to be followed when the RPAS encounters an emergency situation. A number of situations are described below as well as the procedure for handling each situation.

As the RPA will always be flying in close proximity to the ground, this leaves little time for the Pilot to react in most emergency scenarios. The Pilot is therefore expected to study this section before operating the RPAS and be able to react to each situation accordingly.

### 8.2 LOSS OF C2 LINK

The Command & Control (C2) link may be compromised by factors such as distance from the control station, radio frequency interference, obstructions between the control station and the UAV, and environmental factors. In the event of a loss of C2 link, the flight controller will engage the pre-programmed failsafe response to either hold its current position or execute an RTL.

#### 8.2.1 POSITION HOLD

The RPA will hold its position and altitude at the time of control link loss. The RPA will remain in this position until either the control link is restored, or the RPA enters LOW BATTERY FAILSAFE MODE, which will trigger the RPA to automatically descend until it touches the ground and power down.

#### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
Announce the emergency situation	Create an exclusion zone beneath and around the position of the RPA.
Attempt to determine the cause of the loss of link: <ul style="list-style-type: none"> <li>• RPS power failure.</li> <li>• External Interference corrupting the control link signal.</li> <li>• RPA beyond control link range.</li> </ul>	

<p>If possible, restore power to RPS and toggle the flight mode switch to regain control of the RPA</p>	<p>Stage First Aid kit and fire extinguisher near the exclusion area.</p>
<p>Move RPS as close to the RPA as possible to minimize the effect of the external interference or weak signal strength. Toggle the flight mode switch to regain control of the RPA.</p>	<p>Make sure the area directly below the RPA is clear of persons and objects during the automated landing procedure.</p>
<p>Once all options of regaining the control link have been exhausted, prepare for the automated landing procedure.</p>	

### 8.2.2 RTL (RETURN TO LAND)

Upon entering FAILSAFE mode, the RPA will fly directly back to the Home Position (Launch area). If the RPA is below the specified RTH Altitude, it will first remain in its current position while ascending to the predetermined altitude. This altitude should be set to be well above the highest obstacle in the flight operation area (See 2.9.4, MOCA).

#### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
<p>Announce the emergency situation</p>	<p>Create an exclusion zone beneath the path of the RPA as it returns to the landing area.</p> <p>Ready the Fire extinguisher.</p>
<p>Attempt to determine the cause of the loss of link:</p> <ul style="list-style-type: none"> <li>• RPS power failure.</li> <li>• External Interference corrupting the control link signal.</li> <li>• RPA beyond control link range.</li> </ul>	
<p>Toggle the flight mode switch as the RPA flies back to the RPS to attempt to regain control of the RPA.</p>	<p>Make sure the area directly below the RPA is clear of persons and objects during the automated landing procedure.</p>
<p>Once all options of regaining the control link have been exhausted, prepare for the automated landing procedure.</p>	

### 8.3 LOSS OF PROPULSION

If PRISM loses propulsion to one or more motors while in the Quadcopter configuration, the likelihood of controlling or recovering the RPA is remote, and a crash or hard landing is almost certain.

If the pilot is operating PRISM in the Coaxial X8 configuration, and loses propulsion in one or more of the 8 brushless electric motors, the pilot may experience difficulty controlling the RPA. In the best case the failure will manifest as a difficulty to control the yaw precisely. The worst case is partial loss of attitude control, but the pilot should still be able to direct the RPA. The behavior of the RPA will be determined by the current AUW of the RPA. If the RPA is lightly loaded, the attitude control will not be greatly affected. If the RPA is flying close to the MTOW specified in the manual, it will be more difficult for the pilot to direct the RPA.

#### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
Abort flight operations and establish manual control of the aircraft.	Move towards the emergency landing area with the first aid kit and fire extinguisher.
<b>Decrease</b> altitude immediately. Direct the RPA towards the predetermined <b>Emergency Area</b> while avoiding any anyone below.	
Establish level of control of RPA	If the Pilot is able to return the RPA to primary landing area: Follow the RPA, making sure to keep the area clear of any people.  Approach any crashed aircraft with extreme caution, as damaged batteries present a fire hazard, and damage to the power control may result in motors spinning up unexpectedly.
If the RPA is deemed controllable, fly back to the primary landing area, avoiding overflying people.	
If not controllable, perform an emergency landing and power down the motors as soon as the RPA touches the ground to avoid damage to the propulsion system.	



## 8.4 LOSS OF BATTERY POWER

In the Event of unexpected loss/partial loss of RPA battery power, the pilot should:

### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
<p><b>Decrease</b> the RPA's altitude as fast as possible, while directing towards the predetermined <b>Emergency Area</b>.</p>	<p>Move towards the emergency landing area with the first aid kit and fire extinguisher.</p>
<p>Take the most direct route to the emergency area, but aim to avoid overflying populated areas.</p>	<p>Announce the emergency situation and make any people in the area aware of the movements of the RPA as it descends towards the emergency area.</p>
<p>Land as quickly as possible</p>	

#### NOTE:

Pilot should begin to slow the descent earlier than normal, to account for the lack of power.

## 8.5 FIRE ONBOARD

In the Event of unexpected loss/partial loss of RPA battery power, the pilot should:

### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
<p><b>Decrease</b> the RPA's altitude as fast as possible, while directing towards the predetermined <b>Emergency Area</b>.</p>	<p>Move towards the emergency landing area with the first aid kit and fire extinguisher.</p>
<p>Take the most direct route to the emergency area, but aim to avoid overflying populated areas.</p>	<p>Use the Fire Extinguisher to put out any fire on RPA and surroundings. Unplug and isolate the batteries as soon as it is safe to do so.</p>
<p>Perform an immediate forced landing while keeping the RPA ground speed as low as possible.</p>	

#### NOTE:

Only use a Class D fire extinguisher for LIPO battery fires

## 8.6 UNCONTROLLED ROTATION

In the event of uncontrolled rotation of the RPA caused by either propulsion or autopilot malfunction the Pilot should take the following actions:

### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
Apply opposite yaw stick to stop or limit the rotation.	Move towards the emergency landing area with the first aid kit and fire extinguisher.
Switch the RPA into POSITION HOLD mode	Clear the area beneath the RPA and around the emergency landing area.
Assess the severity of the situation: <ul style="list-style-type: none"> <li>• How fast is the rotation, is it increasing?</li> <li>• Can the RPA maintain position and altitude?</li> <li>• How close is the RPA to people on the ground?</li> <li>• Proximity to emergency landing zone?</li> </ul>	
If the RPA is able to maintain its position and the rotation is not increasing, pilot should move the RPA towards the Emergency Landing zone.	Move towards the emergency landing area with fire extinguisher.
If the RPA cannot maintain altitude, The Pilot should attempt to fly the RPA towards the Emergency Landing zone. Perform a forced landing	If the pilot indicates that the RPA is not controllable, the observer should stay clear of the RPA as the pilot performs an emergency landing.

## 8.7 FLIGHT CONTROLLER SYSTEM FAILURES

Unexpected behavior can be due to erroneous sensor readings, degraded GPS signal reception, or compass issues.

PRISM is equipped with redundancies of major systems, but the PIC should not continue flight after an error has been reported.

Potential system failures include: Flight controller IMU; GPS/compass; attitude telemetry and stabilization.



### 8.7.1 IMU FAILURE:

If an IMU error occurs, the Autopilot will alert the PIC and will switch IMU control to one of the redundant modules.

#### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
Confirm control of the RPA's attitude.	Maintain visual contact with the RPA and assist the pilot with orientation and positioning.
If no control, declare emergency and try to direct RPA to emergency area	If the pilot indicates that the RPA is not controllable, move towards the emergency landing area with the first aid kit and fire extinguisher.
Make use of the onboard pilot camera to determine RPA attitude and orientation.	
If controllable, fly back to the landing area, avoiding overflying populated areas.	Be ready to unplug the RPA and use the fire extinguisher if necessary.

### 8.7.2 GPS FAILURE:

If a GPS error or failure occurs, the autopilot will alert the PIC and will automatically switch to ALT HOLD mode. The RPA will no longer be able to hold its current horizontal position, but it should not climb or descend uncontrollably. It is also possible that there is a significant degradation of GPS signal strength, which is not recognized by the autopilot. In this case, the RPA may begin an uncontrolled movement while still in POS HOLD MODE.



**ACTIONS TO BE PERFORMED BY:**

<b>PILOT</b>	<b>PAYLOAD OPERATOR / OBSERVER</b>
Immediately switch the RPA into ALTITUDE HOLD mode (if not automatically done by autopilot) and prepare to control the RPA's flight direction against atmospheric influence.	Maintain visual contact with the RPA and assist the pilot with orientation and positioning.
Confirm PIC control of the RPA's attitude.	If the pilot indicates that the RPA is not controllable, move towards the emergency landing area with the first aid kit and fire extinguisher.
Make use of the onboard pilot camera to determine RPA attitude and orientation.	
Fly back to the landing area, avoiding overflying populated areas.	Be ready to unplug the RPA and use the fire extinguisher if necessary.
If the RPA is not controllable, direct it towards the emergency area while decreasing altitude and perform a forced landing.	

### 8.7.3 COMPASS FAILURE:

If a Compass error or failure occurs, the RPA will enter an uncontrolled circular movement (toilet-bowling). It may also tilt in a direction other than the one input on the RPS (dog-legging). The autopilot should alert the PIC and automatically switch to ALT HOLD mode. It is possible that the autopilot will not automatically exit POSHOLD mode. In this case the PIC, should recognise the uncontrolled movement and exit POSHOLD manually. The RPA will on longer be able to hold its current position or perform a safe RTL failsafe.





**ACTIONS TO BE PERFORMED BY:**

<b>PILOT</b>	<b>PAYLOAD OPERATOR / OBSERVER</b>
Immediately switch the RPA into ALTITUDE HOLD mode (if not automatically done by autopilot) and prepare to control the RPA's flight direction against atmospheric influence.	Maintain visual contact with the RPA and assist the pilot with orientation and positioning.
Confirm PIC control of the RPA's attitude.	If the pilot indicates that the RPA is not controllable, move towards the emergency landing area with the first aid kit and fire extinguisher.
Make use of the onboard pilot camera to determine RPA attitude and orientation.	
Fly back to the landing area, avoiding overflying populated areas.	Be ready to unplug the RPA and use the fire extinguisher if necessary.
If the RPA is not controllable, direct it towards the emergency area while decreasing altitude and perform a forced landing.	

## 8.8 LOSS OF VISUAL CONTACT WITH THE RPA

This RPA is certified to fly only in VLOS or E-VLOS conditions. Flying outside of these parameters can cause loss of Radio Control link or separation from obstacles, terrain or other aircraft. It is therefore imperative that the pilot maintains visual contact with the RPA.



**ACTIONS TO BE PERFORMED BY:**

<b>PILOT</b>	<b>PAYLOAD OPERATOR / OBSERVER</b>
Immediately switch the RPA into POSITION HOLD mode (RPA will maintain at is current position) and cancel any automated flight processes which are moving the RPA farther out of LOS.	Reposition to regain visual contact with the RPA and assist the pilot with orientation and positioning.
Gain altitude as required to position the RPA for better visual contact.	Keep visual contact with the RPA and Update the pilot with information via 2-way communication system.
Make use of the onboard pilot camera and OSD to determine RPA position and orientation.	Be ready to unplug the RPA and use the fire extinguisher if necessary.
If the observer has Visual contact, reposition RPS to regain visual contact with RPA.	
If the RPA is not operating near people, roads or buildings, Pilot should force RTH, then listen for the RPA and take over control as soon as visual contact is regained.	

**8.9 CLOSE PROXIMITY TO MANNED AIRCRAFT**

**ACTIONS TO BE PERFORMED BY:**

<b>PILOT</b>	<b>PAYLOAD OPERATOR / OBSERVER</b>
Immediately decrease altitude as low as possible for ensure separation from manned aircraft.	Be aware (Look and Listen) for any manned aircraft entering the flight area.
	Inform the pilot of the position and trajectory of any other aircraft entering the area.



## 8.10 SUDDEN CHANGE IN WIND CONDITIONS

A sudden increase in wind strength can catch a RPA pilot unaware. Increased winds will add time to the flight and drain the battery faster. The pilot should be especially aware if the RPA is operating far downwind of the pilot.

### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
If the RPA is struggling to make ground against the wind: The pilot should drop altitude as low as possible to take advantage of the lower wind speeds closer to the ground.	Be aware of any change in wind conditions and inform the pilot.
Exercise caution when flying downwind of large objects that can create turbulent air or low-level wind shear.	

## 8.11 INCAPACITATION OF PILOT

In the event of the pilot becoming incapacitated during the flight operations, either the payload operator or observer should take control of the RPS.

### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
N/A	Take control of the RPS and switch the RPA into POSITION HOLD mode (it will maintain its current position)
	Assess the state of the pilot. If necessary, call from medical assistance.
	If either the payload operator or observer holds a Valid Remote pilot license, they may take control of the RPA and perform a landing as per normal procedures.
	If not, turn the Transmitter off and force a Failsafe mode and follow the appropriate procedure.

## 8.12 FLYAWAY EVENTS

A true flyaway event – where the aircraft continues horizontal or vertical flight independent of controller input or flight plan – is highly unlikely on PRISM platform. However, it is possible under a narrow set of circumstances. This is the recommended response procedure.

### ACTIONS TO BE PERFORMED BY:

PILOT	PAYLOAD OPERATOR / OBSERVER
Abort flight operations and attempt to establish manual control of the aircraft.	Notify affected airspace users and authorities: <ul style="list-style-type: none"> <li>• Estimated position and altitude of the UAV.</li> <li>• Estimated heading, ground speed.</li> <li>• Time of the flyaway and estimated remaining endurance in minutes.</li> <li>• A physical description of the UAV.</li> </ul>
Toggle the flight mode switch between flight modes	
Reset the C2 link by power cycling the Remote control	



## CHAPTER 9: RPAS HANDLING AND SETUP

### 9.1 INTRODUCTION

This Chapter contains manufacturer recommended procedures for proper handling, storage and care of the RPAS. These instructions should be followed if the RPA is to retain its original performance and dependability. This section will also explain how to assemble and work on various subsystems of the aircraft.

### 9.2 SUBSYSTEMS ASSEMBLY & INTEGRATION

The following sections will assist with the assembly and integration of various subsystems within PRISM. This includes the integration of various payloads, battery installation, canopy removal, and accessing the main frame for custom integrations.

#### 9.2.1 REMOVABLE BATTERY PACK ASSEMBLY

Every PRISM aircraft is shipped with one removable payload receptacle and one PRISM Removable Battery Tray Assembly Kit. The Battery Tray Assembly Kit contains the following:

- 2x PRISM Battery Trays
- 4x Adhesive Velcro Pairs (Fluffy and Angry)
- 4x 18" Straps (for securing small to medium size batteries to the battery tray)
- 4x 24" Straps (for securing large to the battery tray)
- 2x Velcro Loop Straps (for securing loose battery wires)

*PRISM Removable Battery Tray Assembly Kit*



**TO ASSEMBLE A BATTERY ONTO A REMOVABLE BATTERY TRAY, PERFORM THE FOLLOWING STEPS:**

1. Attach the adhesive velcro pieces to both the battery and battery tray.
2. Place the battery onto the battery tray. Ensure that it is aligned in such a way that the battery lead is facing the same direction as the pointed end of the battery tray. For smaller batteries, they may be placed in the center of the tray. For larger batteries, there may be limited space between both batteries which may require the user to offset one battery to the left and the other to the right.
3. Insert the long velcro straps into the removable battery tray and pull tight. For larger batteries, there may be limited space between both batteries which may require the user to have the metal loops on the outsides of the packs (the left battery would have the loop on the left, and the right battery would have the loop on the right).
4. Test fit the battery tray onto the removable payload receptacle to ensure a good fit.
5. For batteries with a long battery lead, use the small velcro strap to take up the excess slack in the lead. This will ensure that the battery leads cannot make contact with the rear propellers while in flight.



▶ *Larger batteries require a slight offset to both the left and right to ensure they will properly fit on the removable payload receptacle.*

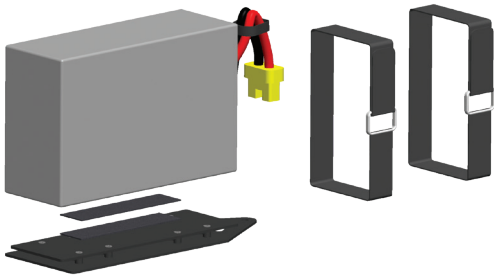


▶ *Attach adhesive velcro to both battery and battery tray. Insert straps and pull tight.*

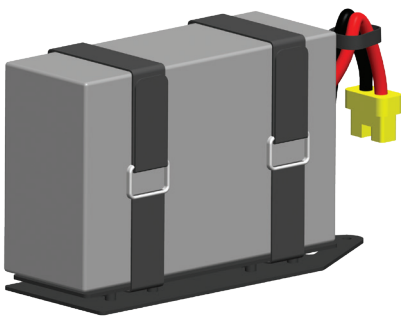




▶ *Assembled battery pack.*



▶ *Smaller battery assembly.*



▶ *Assembled battery pack.*





- ▶ **Battery lead securely fastened with included velcro strap. This must be performed on batteries with longer power wires! Long wires may become entangled in rear propellers if they are not properly secured!**



- ▶ **2x 12s 16,000mAh packs installed onto aircraft**



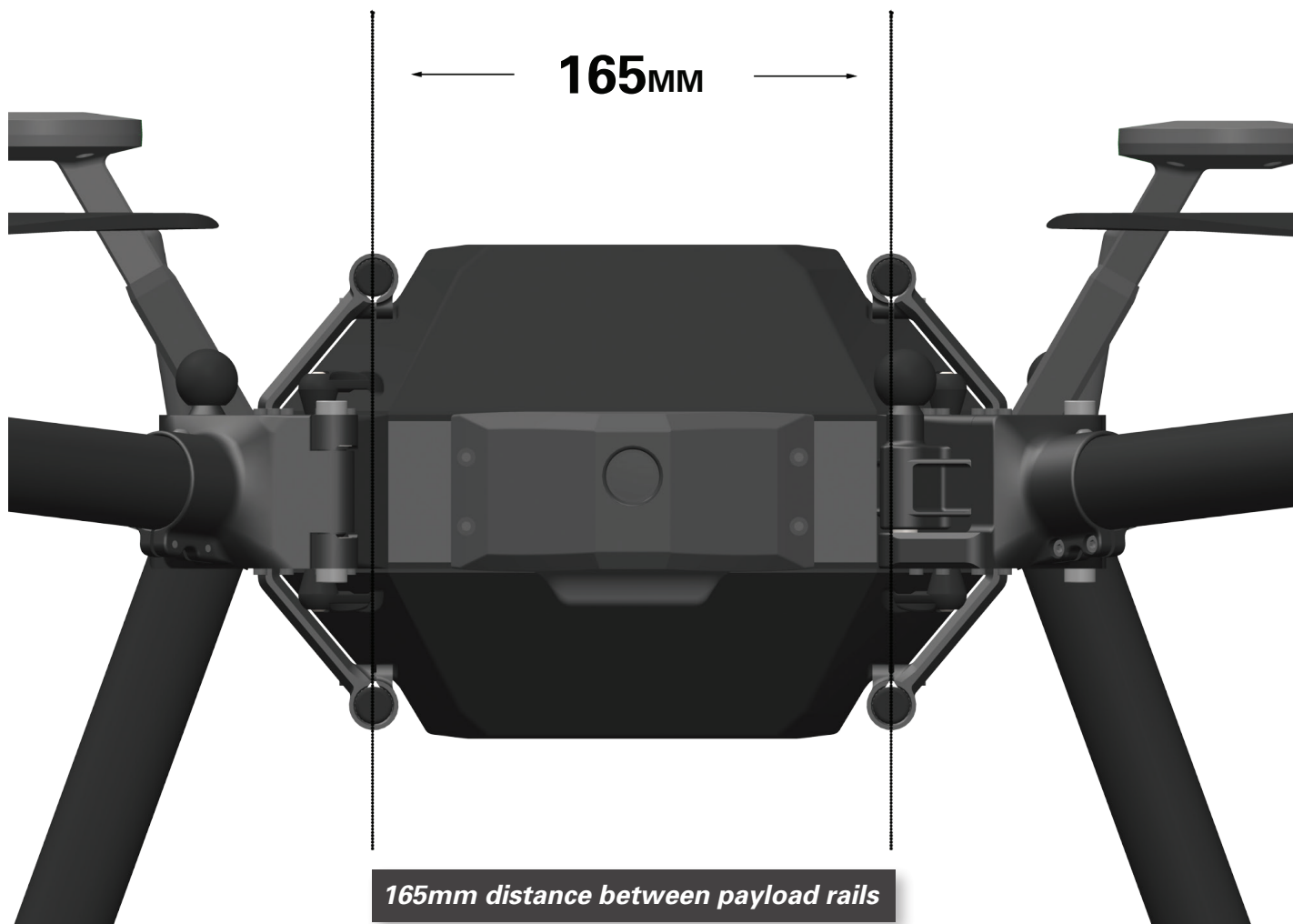
- ▶ **2x 12s 10,000mAh packs installed onto aircraft**





## 9.2.2 PAYLOAD RAIL SYSTEM

PRISM was developed to easily accommodate payloads of a wide variety. By utilizing a 12mm carbon fiber rail system on both the top and bottom of the aircraft, users are able to easily install both payloads and flight batteries on either the top and bottom of the aircraft. The horizontal distance between these payload rails is 165mm, when measured from the center of each payload rail.



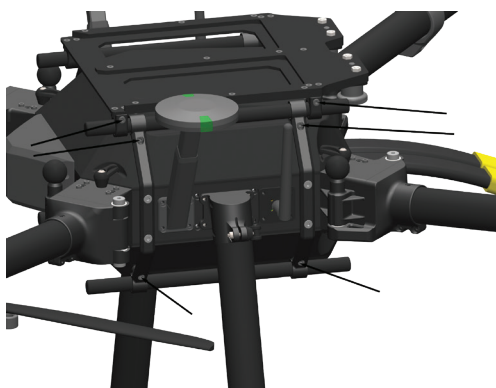
PRISM ships with the removable payload receptacle factory installed onto the top of the aircraft. This removable payload receptacle can accept a wide variety of accessories, as well as battery packs. Because this receptacle can be top or bottom mounted, this means that the battery packs can be installed on both the top and bottom of the aircraft with ease.





### 9.2.3 INSTALLING & REMOVING PAYLOADS ON THE PAYLOAD RAIL SYSTEM

In order to add a payload to the 12mm rail system, the 12mm carbon fiber rails must first be removed. To remove the payload, simply loosen the m3 bolts on both the payload rail mount and on the payload receptacle. Perform this for both sides. Once these rails are loose, simply remove the payload rails.



▶ *Loosen the m3 bolts on both the payload rail mounts and payload receptacle using an m2.5 hex bit*



▶ *Remove the payload rails.*



▶ *PRISM with payload rails removed.*



At this time, a new payload such as a gimbal, camera system, isolation damper, or other can be installed. For this, simply install payload rails through the payload, and re-tighten the m3 bolts. **These bolts must be secured before flight!**



▶ **Mount the payload to the aircraft using the 12mm payload rails. Tighten the m3 bolts on the payload mount to secure the payload.**



▶ **Payload secured.**

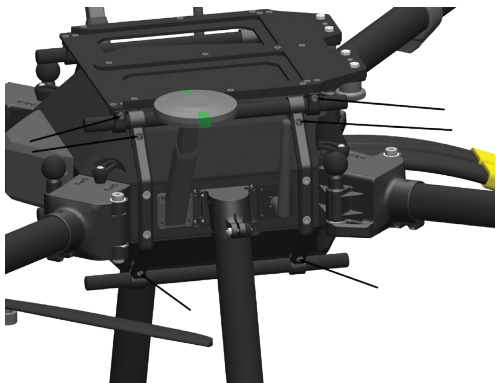
## 9.2.4 REMOVING THE TOP & BOTTOM CANOPY

PRISM was designed to house electronics on both the top and bottom of the main frame. These electronics are protected from both moisture and dust with a removable cover, known as the canopy. Therefore, there are two canopies: one to cover the top of the frame and the other to cover the bottom of the frame. These canopies are identical and can be mounted either on the top or the bottom of the aircraft. The canopies are attached via four mounting points, which can easily be rotated for easy removal. Each canopy has two cooling fans to allow air to circulate, which is essential in hot climates. Lastly, each canopy has a gasket which helps it seal to the frame to protect the electronics from the elements.

**In order to gain access to the electronics and remove the canopies:**



1. With the payloads removed (as shown in the previous section), loosen the 4 bolts from each side of the aircraft which attach the payload rails to the main frame using an m2.5 hex driver. NOTE: These bolts are captured inside the payload mounting rail so there is no need to fully remove them from the payload mounting rails.

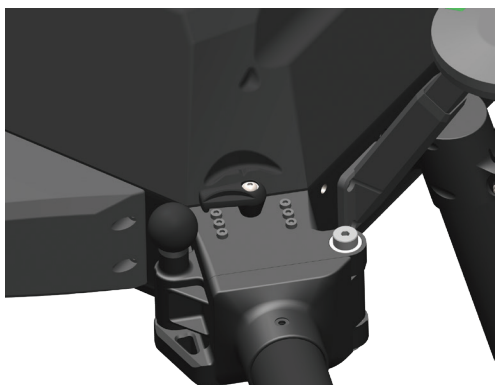


▶ **Loosen the four bolts from each side (4 on each side, 8 total) using an m2.5 hex driver.**



▶ **Payload mounts have been removed.**

2. Rotate each of the canopy posts 90 degrees. Once all four canopy posts have been rotated away from the canopy, the canopy will no longer be held in place and can be removed.



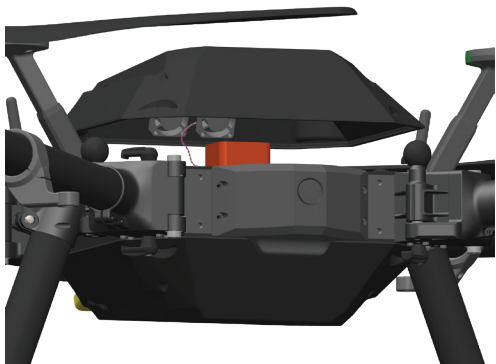
▶ **Canopy post rotated out of the way.**



3. Remove the canopy from the frame.

**NOTE:**

There is a wire that runs from the canopy fans to PRISM's top and bottom frame. This wire provides power to the fans. This wire connector must be removed before removing the top and bottom canopy! Failure to remove this connector and pulling hard on the canopy may result in damage to the top/bottom PRISM main frame circuit board!



▶ *Remove the canopy.*



▶ *Top and bottom canopies removed. Be sure to remove the fan wires from the circuit board!*

4. Repeat the process to remove the bottom canopy.

## 9.2.5 POWERING, CONTROLLING AND VIEWING EXTERNAL PAYLOADS

PRISM was developed to be a platform which can accept a wide variety of payloads and accessories. The aircraft is capable of powering and controlling a wide variety of payloads with ease.



## POWER:

PRISM Offers power to peripheral devices and payloads in the following ways:

TOP FRAME	BOTTOM FRAME	EXTERNAL POWER PLATE
5V	5V	5V
12V	12V	12V
24V	24V	24V
		12s Battery Voltage

### TOP FRAME:

Regulated power voltage is available to easily power peripheral devices on the top frame.

5V: Power is available through multiple JST GH\_3 pins

12V: Power is available through one XT-60 connector

24V: Power is available through one XT-60 connector

### BOTTOM FRAME:

Regulated power voltage is available to easily power peripheral devices on the bottom frame.

5V: Power is available through multiple JST GH\_3 pins

12V: Power is available through one XT-60 connector

24V: Power is available through one XT-60 connector

### EXTERNAL POWER PLATE:

Regulated power voltage is available to easily power peripheral devices from the outside of the aircraft. This allows a weatherproof connection to be made from the payload to the aircraft.



5V: Power is available through the 5 pin Switchcraft connector as well as the 12 pin data connector

12V: Power is available through the 5 pin Switchcraft connector

24V: Power is available through the 5 pin Switchcraft connector

48V: Power is available through the 5 pin Switchcraft connector

### AVAILABLE AMPERAGE PER EACH REGULATED VOLTAGE:

Each of the regulated voltages are capable of the following amperage output:

**5V: 2A available to the entire system.** Do not exceed a maximum of 2A combined when powering peripheral electronics!

**12V: 8A available to the entire system.** Do not exceed a maximum of 8A combined when powering peripheral electronics!

**24V: 6A available to the entire system.** Do not exceed a maximum of 8A combined when powering peripheral electronics!

### DATA:

PRISM Offers various data ports to control peripheral devices and payloads via the onboard Cube flight controller in the following ways:

TOP FRAME	BOTTOM FRAME	EXTERNAL POWER PLATE
4 Serial Ports to Cube (Telem1 [Serial 1], Telem2 [Serial 2], GPS1 [Serial 3], GPS2 [Serial 4])	3 CHANNEL PASS THROUGH TO TOP FRAME	USB to Cube (Used for Programming / Down- loading Flight Logs)
2X CAN1 Ports to Cube		SBUS Out From Cube
2X CAN2 Ports to Cube		Telem2 [Serial2] from Cube
		GPS2 [Serial 4] from Cube



By utilizing these various data ports, users are able to integrate and control various peripheral components such as gimbals, cameras, onboard computers and more.

**SPECIAL NOTE:**

The Telem2 and GPS2 ports are shared by both the external connector as well as the Cube carrier board. This means that only one instance may be used at a given time.

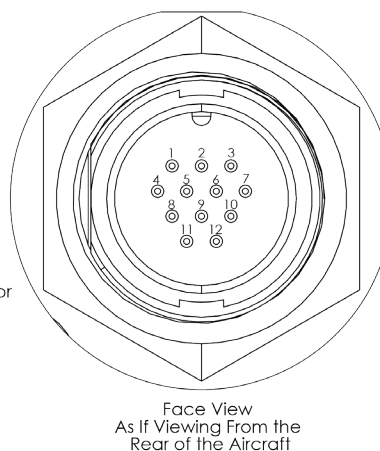
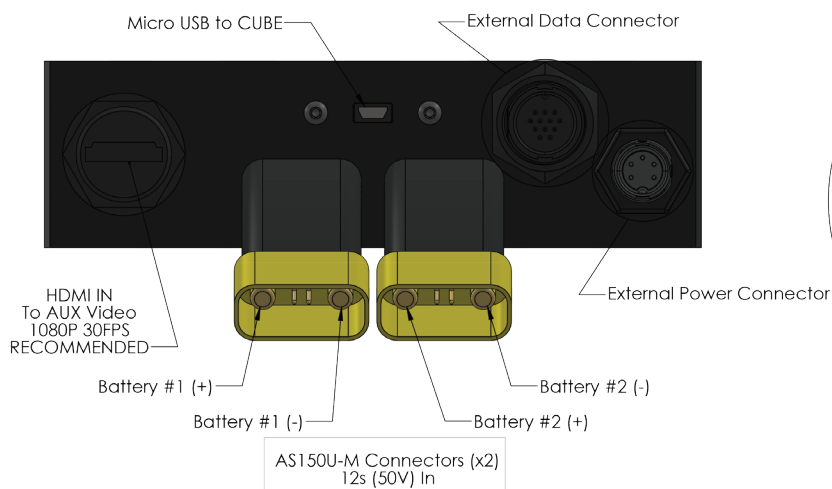
**VIDEO:**

By utilizing an external weatherproof HDMI connector, PRISM is able to accept a video feed from an external camera. It is highly recommended that the video stream is set to 1080p 30FPS.

The video stream is available from the home screen of the WattsQGC App. Simply press the AUX or FPV button to toggle between the two video feeds.

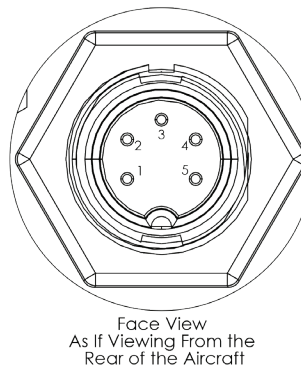
Rear Power Panel Additional Information

Please refer to the following diagram for additional information on the Rear Power Panel, which offers auxiliary power, data, and video.



**External Data Connector PINOUT**

- 1: SBUS Out from CUBE
- 2: 5V +
- 3: Ground
- 4: Accessory ID
- 5: Accessory ID
- 6: Accessory ID
- 7: Accessory ID
- 8: RX2
- 9: TX
- 10: RX
- 11: Not Connected
- 12: TX2



**External Data Connector PINOUT**

- 1: Battery Voltage +
- 2: 24V +
- 3: 12V +
- 4: 5V +
- 5: Ground -

**ADDITIONAL CONNECTOR INFORMATION**

**External Data Connector**

Total Pin Count: 12 Pin  
 Connector Manufacturer: Conxall / Switchcraft  
 Connector Part Number: W4282-12PG-300  
 Mating Connector Part Number: W3282-12SG-535

**External Power Connector**

Total Pin Count: 5 Pin  
 Connector Manufacturer: Conxall / Switchcraft  
 Connector Part Number: EN3P5MX  
 Mating Connector Part Number: EN3C5FX / CAEN3C5F07990



## 9.3 ASSEMBLING AND DISASSEMBLING THE AIRCRAFT

Please refer to the following section for proper assembly and disassembly before and after flight operations. It is imperative that these sections are followed carefully to ensure safe flights.

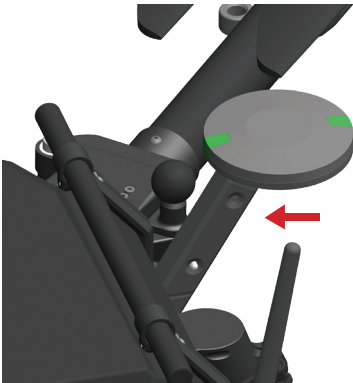
### 9.3.1 ASSEMBLY FOR FLIGHT

1. Remove the main aircraft body from its transport container and place it on a flat, level surface.

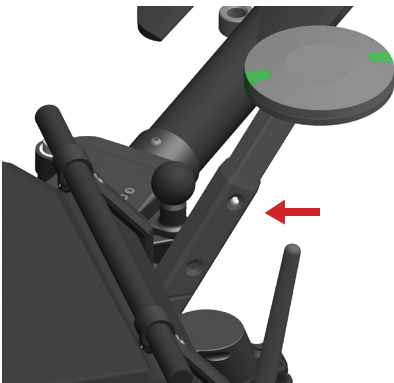
■ **Figure 54: PRISM AIRCRAFT STORED IN ITS TRANSPORT CONTAINER**



2. Slot the T-shaped landing gear into their receptacles on the underside of the central airframe and turn the cam lock until it is in the locked position.
3. Depress the release pin on each of the collapsible GPS masts and tug gently on the GPS disk to extend the masts until they lock in their extended positions.



▶ *Folded Position for Transport in Carry Case*



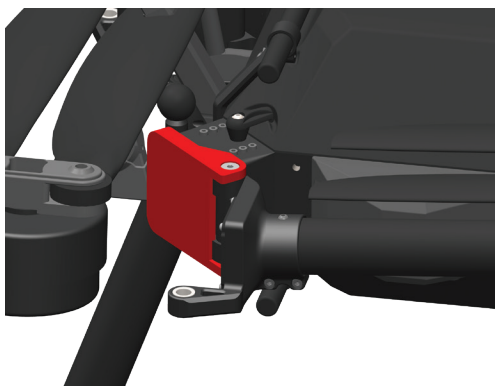
▶ *Extended Position*



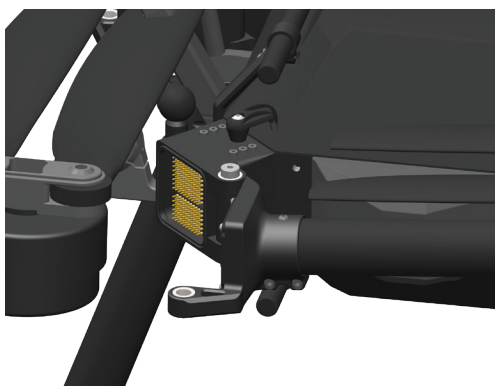
▶ *Aircraft Ready to Fly, GPS Antennas in Extended Position*



4. Remove the four red plastic arm protectors at the four corners of the aircraft body where the booms attach. This will expose the data and power pins that make up the Propulsion ID system, so do not leave these pins exposed for a long time, particularly in dusty or wet environments. Store the red plastic protectors where they will not become dirty or lost.



▶ **Arm Socket Covers - Remove for Flight**



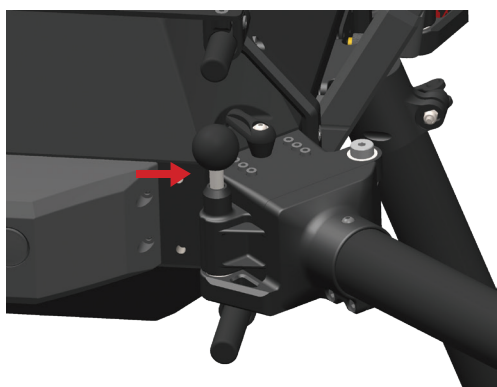
▶ **Arm Socket Covers - Install for Transportation**

5. Release the arm-locking pins by lifting the knob to the left of each corner of the airframe. Swing each arm outward into the extended flight position, one at a time, until the Propulsion ID power pins are fully engaged with the contact points at the bases of the arms, and the arm is flush against the central airframe. Ensure each arm is correctly locked into flight position and the bolts are firmly set by pressing down on each locking knob.

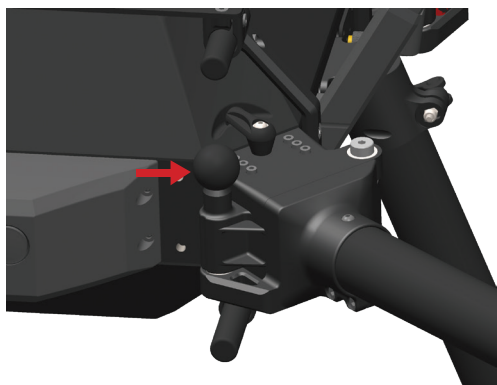




▶ *Open the arms by pulling up on the pin. Swivel arm into the socket.*



▶ *Arm is aligned with pin open.*



▶ *Push the locking pin down firmly to lock the arm into place. This is designed to be a tight fit, so some force may be required.*

6. Ensure the data uplink/downlink antennas on the left and right sides of the aircraft are positioned outward and up at about a 45-degree angle.
7. Remove the protective cloth covers from each of the motors and set the covers aside where they will not be blown away by the propwash during operations. Unfold the propellers on the motors.

8. On the battery tray receptacle, pull the locking pin away from the battery tray and rotate a quarter turn to allow the pin to lock in the extended position. Slide the battery tray into the battery tray receptacle, ensuring that the battery leads are facing the power distribution plugs emerging from the side of the main aircraft body, and that the locking holes in the battery tray are lined up with the locking knobs on the airframe. Release the locking knobs by rotating each one clockwise a quarter turn so that the springs push the bolts through the holes in the battery tray. This will ensure the battery tray is properly secured. Test the battery tray by pulling forcefully on the battery to ensure it is properly secured.



▶ ***Install batteries by sliding each pack onto the removable payload receptacle. Note the two locking pins are in the downward position to accept the battery trays.***



▶ ***Batteries correctly installed. NOTE: Locking pins are now in the "locked" position.***



**WARNING:**

Some batteries may be supplied with a long power lead wire. Users must ensure that this slack is taken up by the supplied velcro straps to ensure that the battery wires do not become caught in the rear propellers during flight!



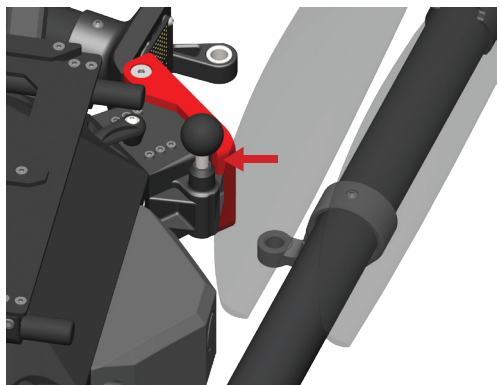


▶ **Batteries installed with Velcro Straps tied around extra long battery leads to ensure they do not make contact with the rear propellers.**

9. Continue assembly of PRISM by attaching the payload, first performing the physical installation, then connecting the data and power connectors.

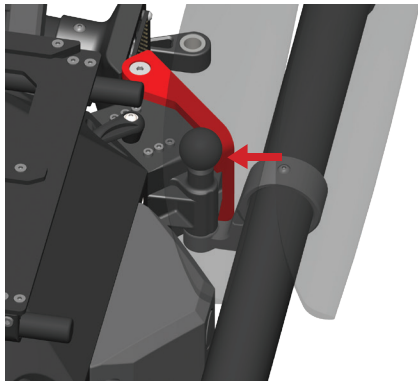
### 9.3.2 DISASSEMBLY AFTER FLIGHT

1. After operations are complete, power down and remove the payload.
2. Before folding the arms of PRISM, the propellers should be folded and secured, and the motors covered with their dust covers. Fold the arms by pulling up on the round release knob on the left side (as-facing) of the attachment point, then folding the boom arm against the side of the main airframe. Lift the attaching pin at the point of contact and allow the arm to lock in place in its folded position. At this time the arm socket covers may be installed to prevent dirt and other particulates from entering into the arm socket.

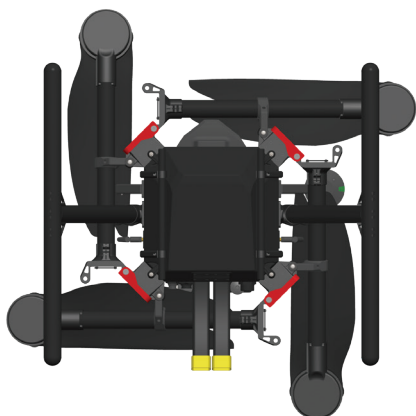


▶ **Pull up on pin**





▶ **Release pin into the arm locking ring to ensure the arms are locked in place for storage and transport.**



▶ **All four arms are locked into place with arm covers installed. View from below the aircraft.**

3. Remove the landing gear by loosening the bolts where the T-bar gear attach to the central airframe and lifting the airframe free. Set the airframe on a flat and level surface.
4. When not in use, the aircraft should be stored inside its case in a climate- controlled environment at room temperature. The covers should remain in place over the arm sockets as well as the propellers, and the arms should be folded in and locked in storage position. The case should be stored upright.
5. Batteries should be serviced and stored separately according to their manufacturer specifications. They may be kept secured to the carbon-fiber battery tray as a set.





## 9.4 RPAS CLEANING AND CARE

RPAS Care should be a priority for the pilot and ground crew. Care for the RPA is part of the preventative maintenance program and will ensure a reliable and long life for the RPAS. The steps below detail procedures for the correct care of the RPA.

1. PRISM should be transported in the case provided by the manufacturer, or in a similar case which provides the same cushioning, immobilization, stability, and level of protection against dust, moisture, or foreign-object debris as the manufacturer's case.
2. It may be necessary to lift and carry the assembled, flight-ready PRISM from one place to another in the field, and to manipulate the aircraft during compass calibration. Lifting PRISM should be done by two persons, who should grasp the aircraft at the base of opposing structural arms. Never lift PRISM by the motors or the extremities of the arms unless lifting all four arms simultaneously. If it is necessary for one person to lift and carry PRISM, that person should approach the aircraft from the back, stand between the two rear arms of the aircraft, and grasp the two opposite arms at either side of the airframe at their base, nearest the center of the aircraft.
3. If it is necessary to move PRISM manually in the field, it is recommended to fold and bag the propellers to prevent damage or injury. The person manipulating the aircraft should be cautious of the payload, which may move freely if not secured or powered on.
4. PRISM should be regularly cleaned of dust and debris accumulated during missions. This is best accomplished using a clean, dry or slightly damp cloth to remove dust. Small amounts of grease or lubricant may be applied periodically to the pivoting arm joints where they attach to the central airframe. Screws which are frequently removed and reinserted, such as the bolts holding the boom arms to the airframe, should be treated with medium-strength thread locker, which should be re-applied when the adhesive flakes off the threads.
5. During standby periods, ensure the RPA is not exposed to direct sunlight and the motors are covered to protect from dust or dirt.
6. Do not operate the RPA in excessively dusty or sandy conditions. If necessary, make use of a landing pad to limit dust created during takeoff and landing.
7. When operating near the coast, limit the RPA's exposure to sea air when not in use.



## CHAPTER 10: RPAS MAINTENANCE AND REPAIRS

### 10.1 INTRODUCTION

This section describes in greater detail, each component of the RPAS, and the minimum information required to ensure PRISM aircraft remains serviceable and safe for airborne operations.

This section is prepared with reference to ASTM F2909 – 14, Standard Practice for Maintenance and Continued Airworthiness of Small Unmanned Aircraft Systems.

### 10.2 SCHEDULED MAINTENANCE

The following scheduled maintenance program must be followed to ensure the RPAS remains serviceable and will perform reliably and safely. The following checklists are to be used in conjunction with the information pertaining to each individual component, found in the section referenced alongside each component.

#### 10.2.1 INSPECTION PROGRAM

Inspection Items (REF)	Inspection Intervals (Whichever comes first)			
	15 Hrs / 1 Months	30 Hrs / 1 Months	45 Hrs / 1 Months	60 Hrs / 1 Months
Propeller Assembly (10.4.1)	X	X	X	X
Motor (10.4.2)	X	X	X	X
Motor Mount Assembly (10.4.3)	X	X	X	X
Airframe (10.4.5)	X	X	X	X
Antennas (10.4.6)	X	X	X	X
Landing Gear (10.4.7)	X	X	X	X
Battery Tray (10.4.8)	X	X	X	X
Electrical systems (10.5)	X	X	X	X
Ground Control Station (10.6)	X	X	X	X
Flight Test (10.7)	X	X	X	X
Firmware update (10.8)	As Released			

## 10.2.2 REPLACEMENT PROGRAM

Replacement Items (REF)	Inspection Intervals			
	15 Hrs	30 Hrs / 6 Months	45 Hrs	60 Hrs / 12 Months 1,000 Plug In's
Main Power Plugs				<b>X</b>

## 10.2.3 OVERHAUL PROGRAM

Overhaul Items (REF)	Inspection Intervals			
	15 Hrs	30 Hrs / 6 Months	45 Hrs	60 Hrs / 12 Months 1,000 Plug In's
Propeller				<b>X</b>

## 10.3 UNSCHEDULED MAINTENANCE

### 10.3.1 INTRODUCTION

This chapter details the maintenance to be completed if one of the following events take place. The steps detailed below should be completed and documented before the RPA is deemed fit for service.

### 10.3.2 HARD LANDING

In the event of a hard landing, without the propellers making contact with the ground, a number of inspections must be conducted before the RPA is deemed fit for service.

- Airframe
- Isodampener or payload connection points
- Landing gear
- Flight Test

### 10.3.3 PROP STRIKE

If any one of the propellers makes contact with the ground or any object while rotating, the following inspections must be carried out and components replaced as required

- Propeller Assembly
- Motor mounts
- Flight Test



### 10.3.4 LOW BATTERY VOLTAGE IN FLIGHT

If the battery voltage drops abnormally low during operation, the battery in question must be inspected according to the battery maintenance program before being cleared for use.

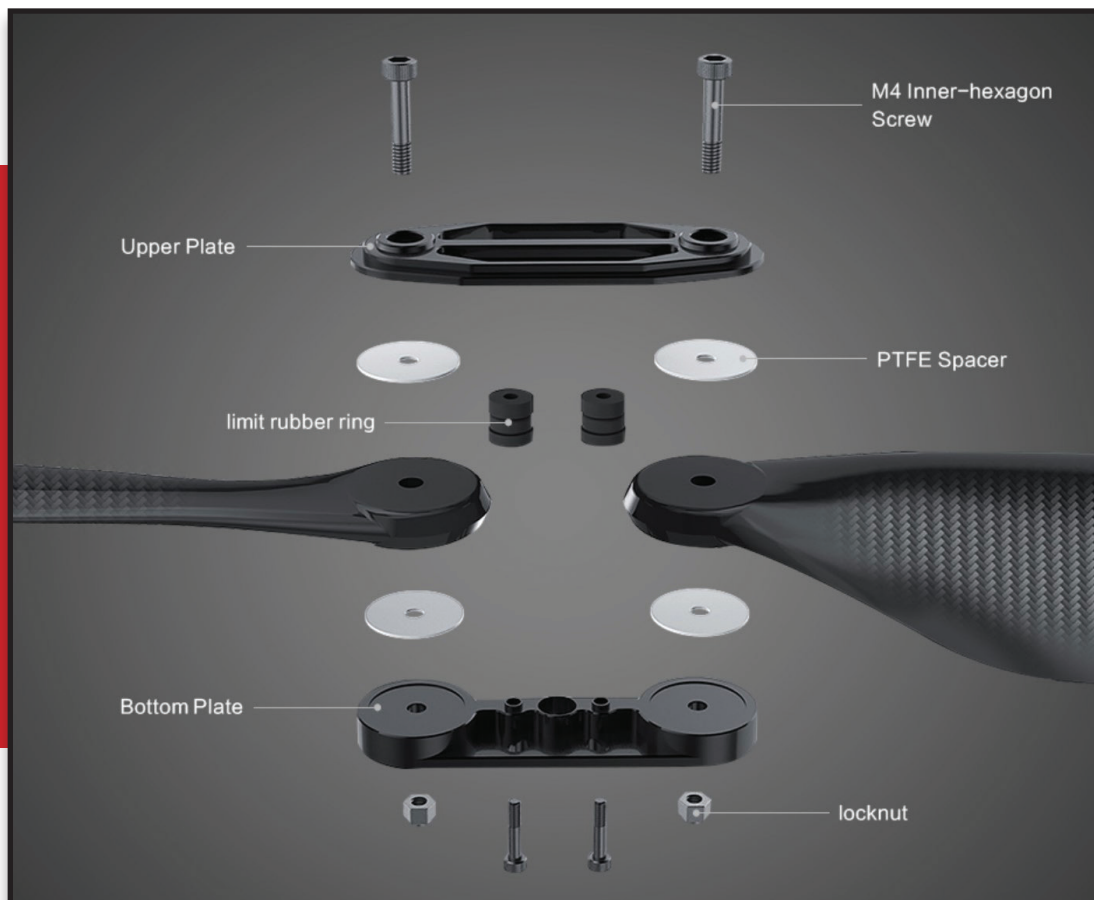
## 10.4 MECHANICAL SYSTEMS

The following section details various components that are precisely engineered to allow PRISM to operate at its optimal performance.

### 10.4.1 PROPELLER ASSEMBLY

The propellers used on this RPA are part of the U8ii and X-U8ii propulsion systems. The propellers are carbon-fiber T-motor 28x9.2" FA folding propellers. A set of folding propellers weighs 328 grams (11.6 ounces).

The folding propeller hub assembly is made up from top and bottom aluminum components that hold the blades and allow them to pivot between PTFE spacers. The top and bottom sections are held together by M4 Inner-hexagon bolts. These bolts also secure the blade to the hub, allowing the blade to pivot around the bolt. The hub is fastened to the motor by 4x m3 Socket Head Cap Screws.



### **(i) PROPELLER BLADES**

Inspect each propeller blade for any signs of cracks, wear or damage. Run fingers along the leading and trailing edges of each propeller to feel for any dents or chips. Run fingers along the top and bottom surfaces to inspect for deformation, cracks or rough areas.

Apply an axial and rotational bending force by hand to inspect the structural integrity of each blade, especially looking for microfractures near the hub.

If necessary, remove the propeller in question and use fine grit sandpaper to remove any imperfections.

Defects or damage on the propeller should be noted in the RPAS Maintenance Logbook. The PIC should use their discretion as to whether the propeller is serviceable or should be replaced.

If storing the propellers for extended periods (6 months or more), it is recommended to remove them from the motor hubs and seal them in a plastic bag in a dry, neutral environment.

Avoid prolonged exposure of the propellers to water, sulfur dioxide, nitrogen dioxide, chlorine, organosilicon compounds, cyano group compounds, and phenols.

### **(ii) PROPELLER HUB**

Inspect the top and bottom hub components for signs of damage or wear.

Inspect for any rotational, lateral or vertical play between the blade and the hub. Any play is a sign of wear or loose bolts and is not tolerated.

The only movement observable should be the blade pivoting around the bolt.

### **(iii) PROPELLER BLADE REPLACEMENT**

In the event that a blade is damaged, or is deemed unserviceable, the blades should be replaced as a pair.

The new blades should be installed with a washer on top and bottom.

Apply threadlocker to the M6 bolts and tighten until the blades cannot pivot. Then release a quarter turn so that the blades can pivot smoothly.

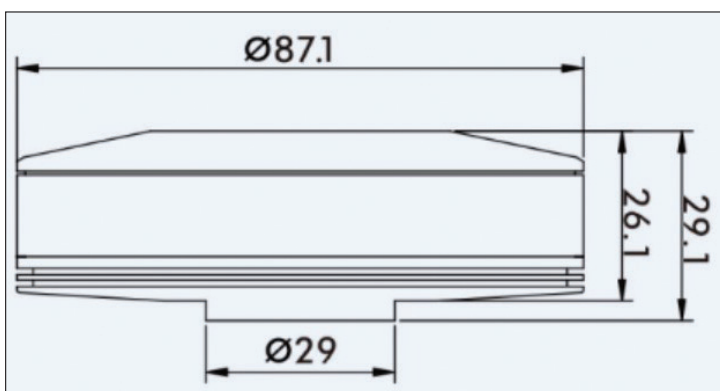
The only movement observable should be the blade pivoting around the bolt.



## 10.4.2 MOTOR

The motors on this RPA are U8ii Brushless DC motors, manufactured by T-motor and supplied as part of the boom arm propulsion set. The motors are designed to operate at 50V (12s Lipo) and each produce a maximum of 7.3 kg thrust at sea level. For the purpose of this maintenance manual, the motor will be discussed in 3 parts below.

### (i) MOTOR BELL (U8ii)



The motors on this RPA are U8ii Brushless DC motors, manufactured by T-motor and supplied as part of the boom arm propulsion set. The motors are designed to operate at 50V (12s Lipo) and each produce a maximum of 7.3 kg thrust at sea level. For the purpose of this maintenance manual, the motor will be discussed in 3 parts below.

### (ii) MOTOR BEARINGS

Motor bearings cannot be visually inspected, as that would require the disassembly of the motor. If any part of the motor is damaged or deemed unserviceable, the entire motor must be replaced.

#### **Axial inspection**

Simulate the force of the thrust of each motor by either pushing or pulling the motor bell along the axis of rotation. Inspect for any noticeable change in the gap between the motor bell and base. This would indicate the motor bell shifting on the motor shaft.

#### **Radial inspection**

Wobble the bell while holding the motor base stationary. Any movement indicates worn or damaged motor bearings.

#### **Rotational inspection**

With the propeller folded into flight position, hold the base firmly and spin the propeller by hand. Feel for any vibrations on the motor base. Listen for any indication of rough rotation. These are indications of motor bearing wear or damage. Replace the motor if necessary.



### (iii) MOTOR BASE

Visually inspect the motor base for any signs of damage, deformation or discoloration. Inspect the Motor Base is securely attached to the motor mount.

Inspect for debris that has been ingested by the motor. Foreign particles can get stuck between the stator and the magnets and cause rough rotation. Debris should be carefully removed in a way that avoids disturbing the wound copper inside.

## 10.4.3 MOTOR MOUNT ASSEMBLY

The Motor Mount assembly attaches the motor to the 30mm carbon boom. This aluminum component also houses the ESC and acts as a heatsink for the power plant.

### (i) MOTOR MOUNT

Inspect the Aluminum motor mount for any signs of damage or wear. Specifically where the mount clamps onto the carbon boom.

Inspect that the 2 x M3 screws that clamp the Motor mount to the boom are fully tightened and there is no play between the motor mount and the boom

Test for play between the motor base and the motor mount.

### (ii) MOTOR ORIENTATION

The motors and propellers are mounted to the boom, such that the propellers rotate in a horizontal plane. Each motor should be orientated in a similar fashion relative to the boom. This ensures that no motor will induce a thrust vector that can cause the RPA to yaw.

With the propellers folded out into flight position, inspect that there is less than 1 cm (0.4 inches) of vertical deviation between the tips of any 2 adjacent propellers.



#### 10.4.4 12MM RAIL SYSTEM

PRISM is equipped with a 12mm rail mounting system hard-mounted on both the top and bottom of the central airframe. Users may adapt and mount any payload to the rail system as long as it does not raise the MTOW above maximum limits or introduce imbalance. The battery tray receptacle uses the same 12mm rail system. The distance between the rail system is 165mm when measured from side to side, while facing either the front or rear of the aircraft.

#### 10.4.5 AIRFRAME

The airframe of PRISM is constructed from carbon fiber and aircraft grade aluminum/steel parts. Structural integrity of the airframe is paramount to the safe operation of the RPA.

##### (i) INSPECT INTEGRITY OF EACH BOOM

- Inspect each boom and note any cracks, scratches, stress marks, delamination or abnormal shape.
- Pay close attention to the area around boom junctions for signs of stress damage

##### (ii) INSPECT BOOM JUNCTIONS WITH CENTER-FRAME

- With the 4 booms fastened in place, inspect each boom to ensure it is seated correctly and there is no play between the boom and the folding mechanism into which it is mounted.
- Simulate the force exerted by the motors and inspect for excessive deflection in the booms or center plate.
- Inspect each of the 6 folding mechanisms are securely fastened between the 2 central body plates.

##### (iii) CARBON CENTER FRAME

- Inspect the entire carbon Center-frame for damage, wear or delamination.
- Ensure all screws are properly torqued.





## 10.4.6 ANTENNAS

### (i) GPS ANTENNAS

The GNSS GPS antennas are mounted to either side of the airframe using collapsible masts. The antennas are the HERE3 model by ProfiCNC. RTK positioning (optional) is provided by a Here+ Base Station integrated with the EchoSky Mobile RPS.

- Inspect each module for damage or wear.
- Inspect the wire connecting the GPS to the flight controller for damage or wear.
- Inspect each folding mechanism to ensure the GPS unit is secured when in upright flight position.

### (ii) C2 LINK ANTENNAS

The EchoSky Mobile system uses 2 x folding antennas, mounted on either side of the PRISM central airframe.

- Inspect that each antenna is securely mounted in a diagonally-downwards orientation.
- Inspect each antenna and mount for damage or wear.
- Inspect the wire connecting to each antenna is not damaged and securely routed.

## 10.4.7 LANDING GEAR

Inspect the Carbon tubes for signs of damage, cracks or wear. Tighten the aluminum junctions that secure each carbon tube.

## 10.4.8 BATTERY TRAY

The battery tray is used to mount all four flight packs to the RPA central body. The tray slides into the 12mm rail mounting system and is secured by 2 twist lock clamps.

- Verify that the battery tray clamps open and close easily, apply lubricant to the tray clamps as needed for smooth function.
- Ensure the clamps lock down in the closed position with the battery tray in place.
- Inspect that the tray slides smoothly into the body.
- Inspect all 4 batteries are secured to the tray, batteries should not be removed from the tray unless necessary for maintenance or replacement.



## 10.5 ELECTRICAL SYSTEMS

The integrity of the electric systems are vital to the safe operation of this RPA. As such, most of the electronics and electrical systems are housed within the body of PRISM.

- Inspect that the LED Navigation lights on each boom are functioning correctly.
- If a Strobe or Beacon light is installed on RPA, inspect for secure mounting and correct functionality.
- Inspect all visible wiring for insulation integrity, shorting, degradation, or corrosion.
- Ensure that the 2 main power plugs are correctly secured to their housing.
- Any electrical contacts should be checked for corrosion, discoloration, or dirt/debris, and any spots cleaned with a mild abrasive cloth and contact-cleaning solvent.

## 10.6 REMOTE PILOT STATION

### (i) HAND HELD CONTROL UNITS

The handheld remote control is used to manually control the RPA flight path. The RPA attitude and altitude is manipulated via 2 control stick gimbals. The unit has a number of switches that change flight modes and can control other RPA features. The ground control station is powered by a built in battery pack.

This unit requires little maintenance, beyond keeping it clean and free of dust. Particles that get stuck in the mechanisms may hinder the smooth and free movement of the control sticks.

- To clean, use a compressed air can to blow away loose particles and a damp cloth to wipe it down.
- Inspect the Transmitter for damage or wear on the sticks, switches and sliders.
- Inspect the antennas for damage, and ability to remain in desired orientation.

### (ii) GROUND CONTROL STATION

The Touch screen tablet or laptop serves as the interface between the pilot and the RPA. The PIC uses the device as a monitor to view real time video feed as well as RPA telemetry. In addition, RPA settings and mission planning can be controlled through the tablet.

- Inspect the screen for damage or cracks.
- Ensure that the tablet/laptop battery is able to hold sufficient charge.
- Inspect the USB cable and plugs for wear or damage
- Inspect the duck antennas are in good condition and correctly screwed into their sockets.
- Ensure the fan vents are clear of debris and dust buildup.



**CAUTION:**

**When operating in cold environments, the tablet battery may not hold charge as expected. The PIC should pay close attention to the battery levels of the RPS as a whole when operating in cold environments. Low battery on the RPS may lead to control link loss and failsafe conditions. Consider applying DC power in the field when operating in the cold.**

---

## 10.7 TEST FLIGHT

After any repair work, alterations, firmware update or unscheduled maintenance has been performed, a test flight must be conducted before the RPAS may be deemed serviceable. This test flight should take place under the following conditions, in order to minimize injury to persons or damage to property or equipment.

- PIC to conduct a thorough preflight inspection
- Test flight area should be set up to ensure operations take place with a 50m buffer between RPA and all persons and property not involved.
- Where possible, attach a dummy payload to simulate the normal payload weight.

The test flight should be conducted as per the following recommendations.

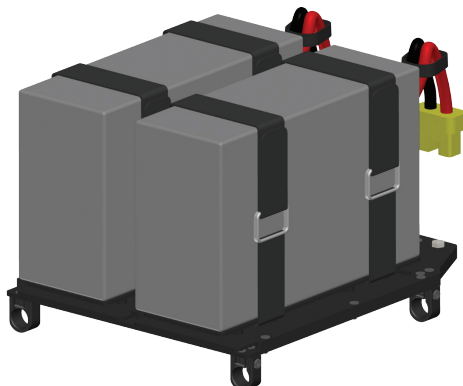
- Select Altitude Hold mode.
- Take off and hover RPA just out of ground effect.
- Confirm that RPA is able to maintain position, altitude and heading without PIC input (RPA is not excessively drifting, bobbing or rotating)
- Enter Position Hold mode, confirm the RPA holds position and heading (no “toilet bowling”)
- Listen to the RPA for any audible indications of abnormal operation (Strange noises or vibrations)
- Observe no error messages displayed on the RPS monitor.
- PIC to command short, sharp stick inputs in all 3 axes, observe RPA reacts accordingly and returns to a stable attitude without over correcting.
- In Position Hold mode, command a straight flight path with either a constant pitch or roll input. Observe the RPA moves in a straight line (no curved flight path). Deviation from a straight flight path can indicate poor Compass calibration.
- Fly the RPA in circuits of increasing speed, while looking out for unstable flight characteristics or abnormal sounds or vibrations.
- Bring the RPA to a full stop from speed and observe stable airframe reactions.

Once the RPA has landed, check all motors for excessive heat buildup. Perform a thorough post flight inspection, checking for any screws or components that may have come loose during the flight.

The RPA may now be declared serviceable



## 10.8 BATTERY MAINTENANCE



### 10.8.1 INTRODUCTION

Each battery must be numbered and the accumulated number of charge/discharge cycles, as well as the amount of charge used during each cycle, is to be logged in the battery logbook. This is done in order to maintain an overview of the Health and lifespan of each battery pack.

The Charger will indicate the amount of charge in mille Amp Hours (mAh) required to bring the battery pack back up to 100% capacity. For the Purposes of the battery logbook, the assumption is made that this value is the amount used during the last flight. This value, along with the accumulated number of charge cycles is logged in the battery logbook.

### 10.8.2 SCHEDULED MAINTENANCE

Inspection Item	Interval (Cycles)			
	20 Hrs / 1 Month	40 Hrs / 1 Month	60 Hrs / 1 Month	100 Hrs / 1 Month
Battery pack exterior for wear and damage	X	X	X	X
Inspect battery connector and wires for wear	X	X	X	X
Measure and log Internal Resistance	X	X	X	X
Balance the cells	X	X	X	X

### 10.8.3 UNSCHEDULED MAINTENANCE

In the Event of Over-Discharge of a Battery Pack (Low Voltage during flight), the pack should be removed from duty until it can be determined if any significant damage was inflicted to the internal cell chemistry. If the Voltage dropped below 3 V per cell under load, irreversible damage would have occurred. The extent of this damage must be determined before the pack can be used again.

Over Discharge will result in an abnormally warm and swollen battery pack and should be dealt with in the following manner:

- Let the pack rest long enough for the cells to return to normal temperature.
- Connect the pack to the battery charger and log the individual cell voltages, individual cell internal resistance and overall pack voltage.
- Charge the pack at a low c rate (0.2 C) to minimize any damage caused by the over discharge.
- Once the charge has completed, log the individual cell voltages, individual cell internal resistance and the total amount of charge that went into the pack.

#### Observations

- Observe the individual cell voltages are all similar
- Observe the Internal resistance of each cell is within acceptable level (less than 10 m $\Omega$ )
- Determine what percentage of the battery capacity was used

#### Test

- Discharge the battery through the charger at 4 amps to 3.3 V per cell under load
- The cells should measure 3.7 V each when the discharge is complete
- Calculate the percentage of total battery capacity used during the test
- The percentage used should be roughly 80% of the total capacity
- If the percentage used is higher than 90% then the pack has suffered irreversible damage and should not be used for flight operations



## 10.8.4 BATTERY STORAGE

Lithium-Polymer battery packs should be left at storage voltage (3.85V/cell) if not being used for more than 7 days. Storage at full charge will decrease the lifespan of the pack and it will become swollen prematurely.

The packs should be stored in a cool, dark and most importantly fireproof location. Li-Po packs have been known to spontaneously combust if damaged or abused. As such, the storage space should be fireproof and sealed to contain any flames or smoke.

## 10.9 REPAIRS

When repairs on PRISM RPAS are necessary, please observe the following recommendations from Watts Innovations, LLC. Failing to do so may limit or void your warranty.

### 10.9.1 MINOR REPAIRS

Minor Repairs may be performed with minimum experience and qualification by following manufacturer guidelines:

- Replacing propellers
- Replacing entire propulsion systems
- Re-calibrating aircraft compass/magnetometer
- Re-calibrating aircraft IMU
- Repositioning GPS/compass antennas for correct orientation
- Replacing Landing Gear components
- Re-calibrating ground control station handset
- Balancing and recharging batteries
- Replacing lost or badly-threaded screws

### 10.9.2 MAJOR REPAIRS

Major repairs should be performed in consultation with Watts Innovations or returned to Watts Innovations for repairs

- Replacing arm sockets, damaged spring loaded pins, or any airframe components
- Replacing the Flight Controller, Power Module, Video Transmitter, Data transmitter, or other system components located inside the central airframe.
- Replacing data or power-supply wiring inside the central airframe
- Any repairs involving the power supply and distribution systems, including soldering
- Any repairs involving ripped, torn, cracked, distorted, or worn metal structural components including the folding arm connectors.



## 10.10 ALTERATIONS

It is essential that the responsible airworthiness authority be contacted prior to any alterations on the RPA to ensure that the airworthiness of the RPA is not affected.

### 10.10.1 MINOR ALTERATIONS

Minor alterations may be performed with minimum experience and qualification by following manufacturer guidelines:

- Alterations not requiring use of tools with minimal effect on aircraft characteristics and performance, e.g.: affixing external, self-powered LED lights to meet equipment requirements for night flights using hook-and-loop attachment systems.
- Custom payloads falling within the maximum gross takeoff weight limits and compatible with the 12mm rail mounting system.

### 10.10.2 MAJOR ALTERATIONS

Major alterations should be performed in consultation with Watts Innovations or specified as customizations during original build:

- Alterations which significantly change aircraft characteristics and center of gravity, e.g: adding an accessory deck to the airframe; modifying the 12mm rail mounting system; changing the rotor configuration; or adding a parachute recovery system.
- Alterations which swap out manufacturer-installed components for third-party components, e.g.: Removing the Pixhawk 2.1/ Cube and installing another flight controller; configuring a custom ground control station handset for custom use; replacing the propulsion system or its components; adjusting the power supply and distribution for more or fewer batteries/different voltages.
- Alterations which exceed the power draw on the aircraft power supplies, e.g.: adding a hard-wired LED lighting system or peripheral device that exceed the onboard power regulators



## SUPPLEMENT 1

CERTIFICATE OF COMPLIANCE



## Supplier's Declaration of Conformity

According to **FCC part 15**Ref. No.: **S19062902406001**

Product: Etias Mobile  
 Applicant: SHENZHEN MICROMULTICOPTER CO.LTD  
 Address: MMC Tech Park, YIHE Road No.1, SHILONG Community, BAO'AN District, Shenzhen, Guangdong Province  
 Manufacturer: SHENZHEN MICROMULTICOPTER CO.LTD  
 Address: MMC Tech Park, YIHE Road No.1, SHILONG Community, BAO'AN District, Shenzhen, Guangdong Province  
 Model: GSM1-N1

*The test sample of product has passed the test according to requirements of the following standards:*

Standard(s):	Test report(s) No.:
47 CFR FCC part 15 subpart B, 10-1-2019	S19062902406001
ANSI C63.4:2014	

*The Sample was tested to conform to the applicable FCC Rules and Regulations. The method of testing was in accordance to the most accurate measurement standards possible, and that all necessary steps have been enforced to assure that all production units of the same equipment will continue to comply with the Federal Communications Commission's requirements.*



Approved by/Date:

*Jiawen Chen* Oct. 17, 2019  
 Department Manager



Shenzhen NTEK Testing Technology Co., Ltd.

Address: 1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao'an District, Shenzhen 518126 P.R. China  
 Tel: +86-755-6115 6588 Fax: +86-755-6115 6599 <http://www.ntek.org.cn>

NTEK





## SUPPLEMENT 2A

CERTIFICATE OF COMPLIANCE



### CERTIFICATE OF RED COMPLIANCE

According to Directive: **2014/53/EU**

Ref. No.: **S19062902403**

Product: Etlas Mobile  
 Trade Mark: N/A  
 Applicant: SHENZHEN MICROMULTICOPTER CO.LTD  
 Address: MMC Tech Park, YIHE Road No.1, SHILONG Community,  
 BAO'AN District, Shenzhen, Guangdong Province  
 Manufacturer : SHENZHEN MICROMULTICOPTER CO.LTD  
 Address: MMC Tech Park, YIHE Road No.1, SHILONG Community,  
 BAO'AN District, Shenzhen, Guangdong Province  
 Model: GSM1-N1

*The test sample of product has passed the test according to requirements of the following standards:*

Standard(s): Refer to attachment      Test report(s) No.: Refer to attachment

*Based on the voluntary assessment of the product sample and technical file, we confirm that the above-mentioned product meets the requirements of the EU directive.*

*The CE mark as show below can be used, under the responsibility of the manufacturer or the importer, after completion of an EU declaration of conformity and compliance with all relevant EU directives.*



Approved by/Date:

*Jabon Chen* Oct. 29, 2019  
 Department Manager



**Shenzhen NTEK Testing Technology Co., Ltd.**

Address: 1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao' an District, Shenzhen 518126 P.R. China  
 Tel: +86-755-6115 6588 Fax: +86-755-6115 6599 Http://www.ntek.org.cn



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SUPPLEMENT 2B

CERTIFICATE OF COMPLIANCE



**CERTIFICATE OF RED COMPLIANCE**

According to Directive: 2014/53/EU

Ref. No.: S19062902403

Attachment:

Standard(s):	Test report(s) No.:
Article 3.1a)	EN 60950-1:2006+A11:2009 +A1:2010+A12:2011+A2:2013
	EN 62479:2010
Article 3.1b)	EN 301 489-1 V2.1.1:2017-02; EN 301 489-17 V3.1.1:2017-02
	EN 55032:2015
	EN 55035:2017
	EN 61000-3-2:2014
	EN 61000-3-3:2013
Article 3.2	EN 300 328 V2.1.1:2016-11

**Shenzhen NTEK Testing Technology Co., Ltd.**

Address: 1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao'an District, Shenzhen 518126 P.R. China  
Tel: +86-755-6115 6588 Fax: +86-755-6115 6599 [Http://www.ntek.org.cn](http://www.ntek.org.cn)



**SUPPLEMENT 3**

**TCB**

**GRANT OF EQUIPMENT AUTHORIZATION**

**TCB**

Certification  
 Issued Under the Authority of the  
 Federal Communications Commission  
 By:

MICOM Labs  
 575 Boulder Court  
 Pleasanton, CA 94566

Date of Grant: 12/25/2019  
 Application Dated: 12/25/2019

SHENZHEN MICROMULTICOPTER CO.LTD  
 MMC Tech Park, YIHE Road No.1,  
 SHILONG Community, BAOAN District,  
 Shenzhen, Guangdong Province,  
 China

Attention: Tracy Liu

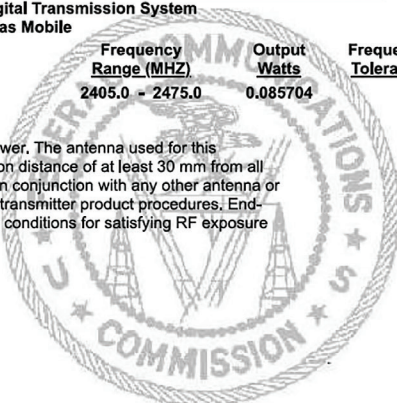
**NOT TRANSFERABLE**

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

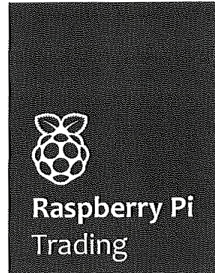
FCC IDENTIFIER: 2AUX4-GSM1  
 Name of Grantee: SHENZHEN MICROMULTICOPTER CO.LTD  
 Equipment Class: Digital Transmission System  
 Notes: Atlas Mobile

<u>Grant Notes</u>	<u>FCC Rule Parts</u>	<u>Frequency Range (MHZ)</u>	<u>Output Watts</u>	<u>Frequency Tolerance</u>	<u>Emission Designator</u>
	15C	2405.0 - 2475.0	0.085704		

Power listed is the maximum conducted output power. The antenna used for this transmitter must be installed to provide a separation distance of at least 30 mm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures. End-Users must be provided with transmitter operation conditions for satisfying RF exposure compliance.



## SUPPLEMENT 4A



Raspberry Pi Trading  
Maurice Wilkes Building  
Cowley Road  
Cambridge  
CB4 0DS

Web  
<http://raspberrypi.org>

**European Declaration of Conformity**

Raspberry Pi (Trading) hereby declares under our own responsibility that the following product:

**Raspberry Pi Zero W**  
**Raspberry Pi Zero WH**

Is in conformity with the essential requirements and other relevant requirements of the Radio Equipment Directive 2014/53/EU. The product is in conformity with the following standards and/or other normative documents:

Restriction of Hazardous Substances (RoHS) Directive 2015/863/EU

**HEALTH & SAFETY (Art. 3(1)(a))**

EN 60950-1:2006/A11:2009 /A1:2010/A12:2011 /A2:2013;  
EN 62311:2008 electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)

**EMC (Art. 3(1)(b))**

EN55032:2012; EN55024:2010 (with reference to EN301489-1v1.9.2 & EN301489-17v2.2.1);

**SPECTRUM (Art. 3(2))**

EN 300 328 v2.1.1 covering wide band transmission systems and data transmission equipment operating in the 2.4GHz ISM band;

Issued at Maurice Wilkes Building, Cowley Road, Cambridge, CB4 0DS. Signed on behalf of the Raspberry Pi (Trading) Limited.



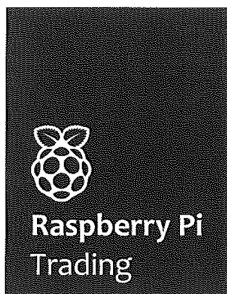
James Adams  
COO  
Raspberry Pi (Trading) Limited

8/8/2019

Date



## SUPPLEMENT 4B



Raspberry Pi Trading  
30 Station Road  
Cambridge  
CB1 2JH

Web  
<http://raspberrypi.org>

**FCC Declaration of Conformity**

Raspberry Pi (Trading) hereby declares under our own responsibility that the following product:

Raspberry Pi Zero W  
Raspberry Pi Zero WH

Are in conformity with the requirements of the following specifications:

ANSI C63.4  
FCC 47 CFR Part 15, Subpart B, Class B Digital Device.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Signed on behalf of the Raspberry Pi (Trading) Limited.



James Adams  
COO  
Raspberry Pi (Trading) Limited

4<sup>th</sup> January 2018

Date