U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

August 18, 2015

Exemption No. 12488
Regulatory Docket No. FAA–2015–2254

Mr. Brent M. Detter
Unmanned Photography
125 Stanley Avenue
Landisville, PA 17538

Dear Mr. Detter:

This letter is to inform you that we have granted your request for exemption. It transmits our decision, explains its basis, and gives you the conditions and limitations of the exemption, including the date it ends.

By letter dated May 22, 2015, you petitioned the Federal Aviation Administration (FAA) on behalf of Unmanned Photography (hereinafter petitioner or operator) for an exemption. The petitioner requested to operate an unmanned aircraft system (UAS) to conduct aerial photography, videography, surveying, mapping, monitoring, and inspections.

See Appendix A for the petition submitted to the FAA describing the proposed operations and the regulations that the petitioner seeks an exemption.

The FAA has determined that good cause exists for not publishing a summary of the petition in the Federal Register because the requested exemption would not set a precedent, and any delay in acting on this petition would be detrimental to the petitioner.

Airworthiness Certification

The UAS proposed by the petitioner is a 3D Robotics IRIS+.

The petitioner requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*. In accordance with the statutory criteria provided in Section 333 of Public Law 112−95 in reference to 49 U.S.C. § 44704, and in consideration of the size, weight, speed, and limited operating area associated with the

aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that the requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*, and any associated noise certification and testing requirements of part 36, is not necessary.

The Basis for Our Decision

You have requested to use a UAS for aerial data collection[1]. The FAA has issued grants of exemption in circumstances similar in all material respects to those presented in your petition. In Grants of Exemption Nos. 11062 to Astraeus Aerial (*see* Docket No. FAA−2014−0352), 11109 to Clayco, Inc. (*see* Docket No. FAA−2014−0507), 11112 to VDOS Global, LLC (*see* Docket No. FAA−2014−0382), and 11213 to Aeryon Labs, Inc. (*see* Docket No. FAA−2014−0642), the FAA found that the enhanced safety achieved using an unmanned aircraft (UA) with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest.

Having reviewed your reasons for requesting an exemption, I find that—

- They are similar in all material respects to relief previously requested in Grant of Exemption Nos. 11062, 11109, 11112, and 11213;
- The reasons stated by the FAA for granting Exemption Nos. 11062, 11109, 11112, and 11213 also apply to the situation you present; and
- A grant of exemption is in the public interest.

Our Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 106(f), 40113, and 44701, delegated to me by the Administrator, Unmanned Photography is granted an exemption from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b), to the extent necessary to allow the petitioner to operate a UAS to perform aerial data collection. This exemption is subject to the conditions and limitations listed below.

[1] Aerial data collection includes any remote sensing and measuring by an instrument(s) aboard the UA. Examples include imagery (photography, video, infrared, etc.), electronic measurement (precision surveying, RF analysis, etc.), chemical measurement (particulate measurement, etc.), or any other gathering of data by instruments aboard the UA.

Conditions and Limitations

In this grant of exemption, Unmanned Photography is hereafter referred to as the operator.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

1. Operations authorized by this grant of exemption are limited to the 3DR IRIS+ when weighing less than 55 pounds including payload. Proposed operations of any other aircraft will require a new petition or a petition to amend this exemption.

2. Operations for the purpose of closed-set motion picture and television filming are not permitted.

3. The UA may not be operated at a speed exceeding 87 knots (100 miles per hour). The exemption holder may use either groundspeed or calibrated airspeed to determine compliance with the 87 knot speed restriction. In no case will the UA be operated at airspeeds greater than the maximum UA operating airspeed recommended by the aircraft manufacturer.

4. The UA must be operated at an altitude of no more than 400 feet above ground level (AGL). Altitude must be reported in feet AGL.

5. The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued airman medical certificate or U.S. driver's license.

6. All operations must utilize a visual observer (VO). The UA must be operated within the visual line of sight (VLOS) of the PIC and VO at all times. The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times; electronic messaging or texting is not permitted during flight operations. The PIC must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The PIC must ensure that the VO can perform the duties required of the VO.

7. This exemption and all documents needed to operate the UAS and conduct its operations in accordance with the conditions and limitations stated in this grant of exemption, are hereinafter referred to as the operating documents. The operating documents must be accessible during UAS operations and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operating documents, the conditions and limitations herein take precedence and must be followed.

Otherwise, the operator must follow the procedures as outlined in its operating documents. The operator may update or revise its operating documents. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator or any law enforcement official upon request. The operator must also present updated and revised documents if it petitions for extension or amendment to this grant of exemption. If the operator determines that any update or revision would affect the basis upon which the FAA granted this exemption, then the operator must petition for an amendment to its grant of exemption. The FAA's UAS Integration Office (AFS−80) may be contacted if questions arise regarding updates or revisions to the operating documents.

8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g., replacement of a flight critical component, must undergo a functional test flight prior to conducting further operations under this exemption. Functional test flights may only be conducted by a PIC with a VO and must remain at least 500 feet from other people. The functional test flight must be conducted in such a manner so as to not pose an undue hazard to persons and property.

9. The operator is responsible for maintaining and inspecting the UAS to ensure that it is in a condition for safe operation.

10. Prior to each flight, the PIC must conduct a pre-flight inspection and determine the UAS is in a condition for safe flight. The pre-flight inspection must account for all potential discrepancies, e.g., inoperable components, items, or equipment. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight.

11. The operator must follow the UAS manufacturer's maintenance, overhaul, replacement, inspection, and life limit requirements for the aircraft and aircraft components.

12. Each UAS operated under this exemption must comply with all manufacturer safety bulletins.

13. Under this grant of exemption, a PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal government. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.

14. The operator may not permit any PIC to operate unless the PIC demonstrates the ability to safely operate the UAS in a manner consistent with how the UAS will be

operated under this exemption, including evasive and emergency maneuvers and maintaining appropriate distances from persons, vessels, vehicles and structures. PIC qualification flight hours and currency must be logged in a manner consistent with 14 CFR § 61.51(b). Flights for the purposes of training the operator's PICs and VOs (training, proficiency, and experience-building) and determining the PIC's ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption are permitted under the terms of this exemption. However, training operations may only be conducted during dedicated training sessions. During training, proficiency, and experience-building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.

15. UAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.

16. The UA may not operate within 5 nautical miles of an airport reference point (ARP) as denoted in the current FAA Airport/Facility Directory (AFD) or for airports not denoted with an ARP, the center of the airport symbol as denoted on the current FAA-published aeronautical chart, unless a letter of agreement with that airport's management is obtained or otherwise permitted by a COA issued to the exemption holder. The letter of agreement with the airport management must be made available to the Administrator or any law enforcement official upon request.

17. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.

18. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property.

19. The PIC must abort the flight in the event of unpredicted obstacles or emergencies.

20. The PIC is prohibited from beginning a flight unless (considering wind and forecast weather conditions) there is enough available power for the UA to conduct the intended operation and to operate after that for at least five minutes or with the reserve power recommended by the manufacturer if greater.

21. Air Traffic Organization (ATO) Certificate of Waiver or Authorization (COA). All operations shall be conducted in accordance with an ATO-issued COA. The exemption holder may apply for a new or amended COA if it intends to conduct operations that cannot be conducted under the terms of the attached COA.

22. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification

(N−Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.

23. Documents used by the operator to ensure the safe operation and flight of the UAS and any documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.

24. The UA must remain clear and give way to all manned aviation operations and activities at all times.

25. The UAS may not be operated by the PIC from any moving device or vehicle.

26. All Flight operations must be conducted at least 500 feet from all nonparticipating persons, vessels, vehicles, and structures unless:
    a. Barriers or structures are present that sufficiently protect nonparticipating persons from the UA and/or debris in the event of an accident. The operator must ensure that nonparticipating persons remain under such protection. If a situation arises where nonparticipating persons leave such protection and are within 500 feet of the UA, flight operations must cease immediately in a manner ensuring the safety of nonparticipating persons; and
    b. The owner/controller of any vessels, vehicles or structures has granted permission for operating closer to those objects and the PIC has made a safety assessment of the risk of operating closer to those objects and determined that it does not present an undue hazard.

    The PIC, VO, operator trainees or essential persons are not considered nonparticipating persons under this exemption.

27. All operations shall be conducted over private or controlled-access property with permission from the property owner/controller or authorized representative. Permission from property owner/controller or authorized representative will be obtained for each flight to be conducted.

28. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS−80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov.

If this exemption permits operations for the purpose of closed-set motion picture and television filming and production, the following additional conditions and limitations apply.

29. The operator must have a motion picture and television operations manual (MPTOM) as documented in this grant of exemption.

30. At least 3 days before aerial filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local Flight Standards District Office (FSDO) with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:
    a. Dates and times for all flights;
    b. Name and phone number of the operator for the UAS aerial filming conducted under this grant of exemption;
    c. Name and phone number of the person responsible for the on-scene operation of the UAS;
    d. Make, model, and serial or N−Number of UAS to be used;
    e. Name and certificate number of UAS PICs involved in the aerial filming;
    f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request;
    g. Signature of exemption holder or representative; and
    h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation.

31. Flight operations may be conducted closer than 500 feet from participating persons consenting to be involved and necessary for the filming production, as specified in the exemption holder's MPTOM.

Unless otherwise specified in this grant of exemption, the UAS, the UAS PIC, and the UAS operations must comply with all applicable parts of 14 CFR including, but not limited to, parts 45, 47, 61, and 91.

This exemption terminates on August 31, 2017, unless sooner superseded or rescinded.

Sincerely,

/s/
John S. Duncan
Director, Flight Standards Service

Enclosures

May 22, 2015

U.S. Department of Transportation
Docket Management System
1200 New Jersey Avenue, SE
Washington, DC 20590

Re: Exemption Request Section 333 of the FAA Reform Act and
Part 11 of the Federal Aviation Regulations

Dear Sir or Madam,

We, Unmanned Photography, are writing pursuant to the FAA Modernization and Reform Act of 2012 and the procedures contained within 14 C.F.R. 11, to request that, Unmanned Photography, an owner and operator of small unmanned aircraft, be exempted from the Federal Aviation Regulations ("FARs") listed below so that We, Unmanned Photography, may operate unmanned aircraft system ("UAS") commercially in airspace regulated by the Federal Aviation Administration ("FAA").

Currently using a 3DR IRSI+Quadcopter[1,2] with intent for aerial photography / videography to showcase constructed projects for architects, landscape architects, and contractors in and around South Eastern Pennsylvania. Other anticipated applications would include surveying, mapping, and construction site monitoring. Use of the UAS for aerial photography, inspections and surveys reduce the need to utilize conventional manned aircraft, manned lifting devices or manned climbing for the same purpose and provides very high quality imagery at a fraction of the cost. These savings result in enhanced safety, efficiency and productivity for the affected activities, as well as environmental benefits.

We, Unmanned Photography, are committed to safety with each flight. Our exemption request would permit operation of ultra-light weight, UAS(s) in tightly controlled and limited airspace. Predetermined in areas away from general public, airports, heliports and vehicular traffic.

Currently, similar lightweight, remote controlled UAS's are legally operated by unmonitored amateur hobbyists with no safety plan or controls in place to prevent catastrophe. We, Unmanned Photography, have personally instilled safety protocols and controls[3] to avoid and prevent public hazard, as well as manned aircraft hazards/catastrophe. This will act to further safety protocols exclusive to lightweight UAS's specific to aerial photography, surveying, and mapping applications as We, Unmanned Photography, record flight data and other information gained through permitted flight operations to share with the FAA through any required FAA reports to assist with future protocol and safety regulation.

Granting our request comports with the Secretary of Transportation's (FAA Administrator's) responsibilities and authority to not only integrate UAS's into the national airspace system, but to "...establish requirements for the safe operation of such aircraft systems [UAS's] in the national airspace system" under Section 333(c) of the Reform Act specific to the use of UAS's for Cinematography/Photo purposes. Further We, Unmanned Photography, will conduct our operations in compliance with the protocols described herein or as otherwise established by the FAA.

For the reasons stated below We, Unmanned Photography, respectfully request the grant of an exemption allowing us to operate ultra-lightweight, remote controlled UAS's for aerial photography, mapping, and surveying operations that are now conducted with fixed wing and rotary conventional aircraft or other manned means of inspections. All of which will promote local economic growth through increased employment and increased tax

base. Both with public safety in mind by keeping heavier manned aircraft containing combustible fuel that that poses potential public hazard.

I. Contact Information

Unmanned Photography
Brent M. Detter
125 Stanley Avenue
Landisville, PA 17538
(717) 468-0700
brentdetter@unmanned-photography.com

II. Regulations Petitioner Petitions for Exemption, If Such Regulations Apply to sUAVs

14 CFR Part 21	14 CFR 91.103	14 CFR 91.405 (a)
14 C.F.R. 45.23(b)	14 CFR 91.109(a)	14 CFR 407 (a) (1)
14 CFR 61.113 (a) & (b)	14 CFR 91.119	14 CFR 409 (a) (2)
14 CFR 61.133 (a)	14 CFR 91.121	14 CFR 417 (a) & (b)
14 CFR 91.7 (a) and (b)	14 CFR 91.151 (a)	
14 CFR 91.9 (b) (2)	14 CFR 91.203 (a) & (b)	

III. The Extent of Relief Sought and the Reason We Seek Such Relief

We, Unmanned Photography, submit this application in accordance with the Reform Act, 112 P.L. 95 §§ 331-334, seeking relief from any currently applicable FARs operating to prevent Us, Unmanned Photography, to pursue aerial photography, surveying, mapping and other flight operations within the national airspace system. The Reform Act in Section 332 provides for such integration of civil unmanned aircraft systems into our national airspace system as it is in the public's interest to do so. Our, Unmanned Photograph's, ultra-lightweight UAS meets the definition of "small unmanned aircraft" as defined in Section 331 and therefore the integration of our ultra-lightweight UAS is expressly contemplated by the Reform Act. We would like to operate our ultra-lightweight UAS prior to the time period by which the Reform Act requires the FAA to promulgate rules governing such craft.

Thereby, providing direct experience and valuable information for formal regulation that can be administered uniformly to all construction related UAS aerial photography, surveying and mapping. The Reform Act guides the Secretary in determining the types of UAS's that may operate safely in our national airspace system. Considerations include: The weight, size, speed and overall capabilities of the UAS's; whether the UAS will be operated near airports or heavily populated areas; and, whether the UAS will be operated by line of sight. 112 P.L. 95 § 333 (a). Each of these items reflect in favor of an exemption for Us, Unmanned Photography. Our UAS utilizes four (4) counter-rotating propellers for balance, control and stability. Our UAS is equipped with GPS and Return to Launch safety technology. Weighing less than ten (10) pounds (far below the maximum 55 pound limit); including camera with gimbal.

We, Unmanned Photography, considers safety as foremost with each flight. Our small unmanned aircraft is designed to hover in place via GPS and operate in less than a 24 knot (15 mph) wind. For safety, stability and fear of financial loss we will not fly in winds exceeding 16 kph (10 mph). Built in safety systems include a Loiter Mode that allows our UAS to hover in place when radio control inputs are released. With three modes to choose from, we utilize the Loiter Mode[4] for aerial photography. This is the safest, most reliable and stable

mode to prevent accident and hazard. When pilot communication is lost our UAS is designed to slowly descend to point of take-off. We do not operate our UAS near airports, Hospitals nor Police heliports, and do not operate near areas where general public is within fifty to one hundred (50-100) yards depending on location, conditions and weather.

We are constantly on alert for any manned aircraft (Police/Medical helicopters, etc.) and are prepared to land/abort immediately to the nearest and safest ground point should a manned aircraft approach our location or we suspect manned aircraft may approach near our location. Our UAS is capable of vertical and horizontal operations, and is flown only within line of sight of the pilot. Utilizing battery power rather than combustible fuels, flights generally last between eighteen (18) to twenty (20) minutes, with an altitude under three hundred (300) feet.

We, Unmanned Photography, utilize a fresh fully charged battery with each flight as a safety precaution; full flight time limit for each battery is eighteen (18) to twenty (20) minutes as tested. We do not operate our UAS at or below manufacturer recommended minimum charge levels for operation; preferring to remain well within a safe operating range to insure adequate communication between radio control and UAS to eliminate potential for crash, loss of control or hazard. Reserve batteries are at hand with each exercise to insure replacement for sufficient safe level of operation.

We do not believe in taking risk that may cause a crash that could create hazard to the public/property/manned aircraft. We have clocked over 50+ hours of hobby level flights for future commercial use to gain familiarization with the characteristics of this specific UAS's performance under different temperature and weather conditions. We also practice computerized simulated flights to maintain adequate skills and response reflex time.

We, Unmanned Photography, am extremely cautious when operating of our UAS/ultra-lightweight unmanned aircraft and will not "create a hazard to users of the national airspace system or the public." 112 P.L. 95 § 333 (b). Given the small size and weight of our UAS it falls well within Congress's contemplated safety zone when it promulgated the Reform Act and the corresponding directive to integrate UAS's into the national airspace system. The UAS, used in hobby flight, has a demonstrable safety record and does not pose any threat to the general public or national security.

IV. How Unmanned Photography's Request Will Benefit the General Public

Aerial photography, surveying and mapping for the Architectural, Engineering and Construction market has been around for a long time through manned fixed wing aircraft and helicopters. However, for small budget companies and average design professionals the expense of such aerial services is cost prohibitive. Only large companies can afford to absorb such expenses, depriving smaller companies from a valuable marketing and construction observation tool. Manned aircraft can pose a threat to the public through potential catastrophic crashes which may result in possible loss of life. Our UAS pose no such threat since size and lack of combustible fuel alleviates any potential threat to the public.

Congress has already proclaimed that it is in the public's interest to integrate commercially flown UAS's into the national airspace system, hence the passing of the Reform Act. Granting Our, Unmanned Photograph's, exemption request furthers the public interest through academic/visual awareness of the geographical benefits in and around the South Florida area. Our ultra-lightweight UAS is battery powered and creates no emissions that can harm the environment. The consequence of our ultra-lightweight UAS crashing is far less

than a full size helicopter or fixed wing aircraft; which are heavy, contain combustible fuel and can cause catastrophic devastation to the public

The public's interest is furthered by minimizing ecological and crash threat by permitting aerial photography, surveying and mapping through our battery operated ultra lightweight UAS's.

Permitting us, Unmanned Photography, to immediately fly within national air space furthers economic growth. Granting our exemption request substantially furthers the economic impact for the south central Pennsylvania Florida community for companies looking to benefit from aerial photography, surveying and mapping. Both of which serve as a stimulus to the community.

V. Reasons Why Unmanned Photography's Exemption Will Not Adversely Affect Safety and How The Exemption Will Provide a Level of Safety At Least Equal To Existing Rule

Our, Unmanned Photograph's, exemption will not adversely affect safety. Quite the contrary, for the reasons stated permitting us, Unmanned Photography, to log more flight time in FAA controlled airspace, with communication with the FAA, will allow me to contribute to the innovation and implementation of new and novel, as of yet undiscovered safety protocols for UAS Pilots that can be embraced for development in cooperation with the FAA. In addition We, Unmanned Photography, submit the following representations of enhancements to current aerial videography and photography:

a. Our UAS weighs less than 10 pounds complete with a small ultra-lightweight high camera
b. We only operate our UAS below 300 feet (well within the 400 foot permissible ceiling set by the FAA Modernization and Reform Act of 2012);
c. Our UAS only operate for 18-20 minutes per flight;
d. We land our UAS prior to manufacturer recommended minimum level of battery power;
e. We pilot our UAS through remote control only by line of sight;
f. Our UAS has GPS a flight safety feature whereby it hovers and then slowly lands if communication with the remote control pilot is lost;
g. We actively analyze flight data and other sources of information to constantly update and enhance safety protocols;
h. We only operate in reasonably safe environment that are strictly controlled, are away from power lines, elevated lights, airports and actively populated areas;
i. We conduct extensive pre-flight inspections and protocol, during which safety carries primary importance;
j. WE always obtains all necessary permissions prior to operation; and,
k. WE have procedures in place to abort flights in the event of safety breaches or potential danger.

Our, Unmanned Photograph's, safety protocols provide a level of safety equal to or exceeding existing rules. It is important to note that absent the integration of commercial UAS into our national airspace system, traditional helicopters and fixed wind aircraft are the primary means of aerial photography, surveying and mapping in the design and construction industry. While the safety record of such helicopters is remarkably astounding, it is far safer to operate a battery powered ultra-lightweight UAS.

a. First, the potential loss of life is diminished because UAS's carry no people on board and only operated in specific areas away from mass populations.
b. Second, there is no fuel on board a UAS and thus the potential for fire or explosions is greatly diminished.
c. Third, the small size and extreme maneuverability of our UAS allow me to remotely pilot away from and avoid hazards quickly and safely.

d. Lastly, given its small size and weight, even when close enough to capture amazing images, our UAS need not be so close to the objects they are focused on through the technology and use of post editing software allowing pan and zoom.

Accordingly, our UAS has been experimentally operated for familiarization/competency and will continue to operate at and above current safety levels.

VI. A Summary - The FAA May Publish in the Federal Register

A. 14 C.F.R. 21 & 14 C.F.R. 91: Airworthiness Certificates, Manuals and the Like

14 C.F.R. 21, Subpart H, entitled Airworthiness Certificates, sets forth requirements for procurement of necessary airworthiness certificates in relation to FAR § 91.203(a)(1). The size, weight and enclosed operational area of Our, Unmanned Photograph's, UAS permits exemption from Part 21 because our UAS meets (and exceeds) an equivalent level of safety pursuant to Section 333 of the Reform Act. The FAA is authorized to exempt aircraft from the airworthiness certificate requirement under both the Act (49 U.S.C. § 44701 (f)) and Section 333 of the Reform Act. Both pieces of legislation permit the FAA to exempt UAS's from the airworthiness certificate requirement in consideration of the weight, size, speed, maneuverability and proximity to areas such as airports and dense populations.

Our, Unamend Photography's, current and projected UAS's meet or exceed each of the elements.

14 C.F.R. 91.7(a) prohibits the operation of an aircraft without an airworthiness certificate. As no such certificate will be applicable in the form contemplated by the FARs, this Regulation is inapplicable.

14 C.F.R. § 91.9 (b) (2) requires an aircraft flight manual in the aircraft. As there are no on board pilots or passengers, and given the size of the UAS's, this Regulation is inapplicable. An equivalent level of safety will be achieved by maintaining a safety/flight manual delineating areas of where safety can be defined.[5] The FAA has previously issued exemptions to this regulation in Exemption Nos. 8607, 8737, 8738, 9299, 9299A, 9565, 9565B, 10167, 10167A,10602, 10700 and 32827.

14 C.F.R. § 91.121 regarding altimeter settings is inapplicable insofar as our UAS utilizes electronic global positioning systems with a barometric sensor.

14 C.F.R. § 91.203 (a) and (b) provides for the carrying of civil aircraft certifications and registrations. They are inapplicable for the same reasons described above. The equivalent level of safety will be achieved by maintaining any such required certifications and registrations by Unmanned Photography.

B. 14 C.F.R. § 45.23: Marking of The Aircraft

Applicable Codes of Federal Regulation require aircraft to be marked according to certain specifications. Our UAS are, by definition, unmanned. They therefore do not have a cabin, cockpit or pilot station on which to mark certain words or phrases.

Further, two-inch lettering is difficult to place on such small aircraft with dimensions smaller that minimal lettering requirement. Regardless, we will mark our UAS's in the largest possible lettering by placing the word "EXPERIMENTAL" on its fuselage as required by 14 C.F.R. §45.29 (f) so that the pilot, or anyone assisting as a

spotter with the UAV will see the markings. The FAA has previously issued exemptions to this regulation through Exemptions Nos. 8738, 10167, 10167A and 10700.

C. 14 C.F.R. § 61.113: Private Pilot Privileges and Limitations: PIC

Pursuant to 14 C.F.R. §§ 61.113 (a) & (b), private pilots are limited to non-commercial operations. We, Unmanned Photography, can achieve an equivalent level of safety as achieved by current Regulations because our UAS does not carry any pilots or passengers. Further, while helpful, a pilot license will not ensure remote control piloting skills. The risks attended to the operation of our UAS are far less than the risk levels inherent in the commercial activities outlined in 14 C.F.R. § 61, et seq. Thus, allowing us, Unmanned Photography, to operate our UAS meeting and exceeding current safety levels in relation to 14 C.F.R. §61.113 (a) & (b).

D. 14 C.F.R. 91.119: Minimum Safe Altitudes

14 C.F.R. § 91.119 prescribes safe altitudes for the operation of civil aircraft. It allows helicopters to be operated at lower altitudes in certain conditions. Our UAS will never operate at an altitude greater than 300 AGL; safely below the standard of 400 AGL. We, Unmanned Photography, will however operate our UAS in safe areas away from public and traffic, providing a level of safety at least equivalent to or below those in relation to minimum safe altitudes. Given the size, weight, maneuverability and speed of our UAS, an equivalent or higher level of safety will be achieved.

E. 14 C.F.R. 91.405 (a); 407 (a) (1); 409 (a) (2); 417(a) & (b): Maintenance Inspections

The above-cited Regulations require, amongst other things, aircraft owners and operators to "have [the] aircraft inspected as prescribed in subpart E of this part and shall between required inspections, except as provided in paragraph (c) of this section, have discrepancies repaired as prescribed in part 43 of this chapter. . . ."

These Regulations only apply to aircraft with an airworthiness certificate. They will not, therefore, apply to Our, Unmanned Photograph's, UAS. However, as a safety precaution WE inspect our UAS before and after each flight.

A Summary: The FAA May Publish in the Federal Register: A. 14 C.F.R. 21 and 14 C.F.R. 91: Airworthiness Certificates, Manuals and the Like. 14 C.F.R. 21, Subpart H, entitled Airworthiness Certificates, sets forth requirements for procurement of necessary airworthiness certificates in relation to FAR § 91.203(a)(1). The size, weight and enclosed operational area of our UAS permits exemption from Part 21 because Our, Unmanned Photograph's, UAS meets an equivalent level of safety pursuant to Section 333 of the Reform Act. The FAA is authorized to exempt aircraft from the airworthiness certificate requirement under both the Act (49 U.S.C. § 44701 (f)) and Section 333 of the Reform Act. Both pieces of legislation permit the FAA to exempt UAS's from the airworthiness certificate requirement in consideration of the weight, size, speed, maneuverability and proximity to areas such as airports and dense populations. Our UAS meets or exceeds each of the elements. 14 C.F.R. 91.7(a) prohibits the operation of an aircraft without an airworthiness certificate. As no such certificate will be applicable in the form contemplated by the FARs, this Regulation is inapplicable. 14 C.F.R. § 91.9 (b) (2) requires an aircraft flight manual in the aircraft. As there are no pilots or passengers, and given the size of the UAS's, this Regulation is inapplicable. An equivalent level of safety will be achieved by maintaining a manual. The FAA has previously issued exemptions to this regulation in Exemption Nos. 8607, 8737, 8738, 9299, 9299A, 9565, 9565B, 10167, maintenance program that involves

regular software updates and curative measures for any damaged hardware. Therefore, an equivalent level of safety will be achieved.

F. <u>In summary, Unmanned Photography seeks an exemption from the following Regulations</u>

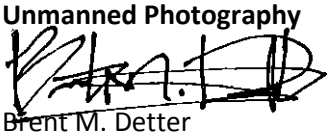
14 CFR Part 21	14 CFR 91.103	14 CFR 91.405 (a)
14 C.F.R. 45.23(b)	14 CFR 91.109(a)	14 CFR 407 (a) (1)
14 CFR 61.113 (a) & (b)	14 CFR 91.119	14 CFR 409 (a) (2)
14 CFR 61.133 (a)	14 CFR 91.121	14 CFR 417 (a) & (b)
14 CFR 91.7 (a) and (b)	14 CFR 91.151 (a)	
14 CFR 91.9 (b) (2)	14 CFR 91.203 (a) & (b)	

To commercially operate our small unmanned vehicle/lightweight unmanned aircraft vehicle in community awareness, aerial photography, surveying and mapping services, and to develop economic platforms for design professionals and contractors to market their projects, services, and documents construction progress. Currently, area design professionals and contractors rely primarily on the use of larger aircraft running on combustible fuel. Posing potential risk to the public.

Granting our request for exemption will reduce current risk levels and thereby enhance safety. Our UAS craft does not contain potentially explosive fuel, is smaller, lighter and more maneuverable than conventional video and photographic aircraft with much less flight time. Further, We operate at lower altitudes and in controlled airspace eliminating potential public risk flying to and from established air fields. We, Unmanned Photography, have been informally analyzing flight information and have compiled safety protocols and the implementation of a flight operations manual for UAS usage that exceeds currently accepted means and methods for safe flight. Formal collection of information shared with the FAA will enhance the FAA's internal efforts to establish protocols for complying with the FAA Modernization and Reform Act of 2012. There are no personnel on board our UAS and therefore the likelihood of death or serious bodily injury is significantly diminished.

Operation of our UAS, weighing less than 10 pounds and travelling at lower speeds within limited areas will provide an equivalent level of safety as that achieved under current FARs. Accordingly We, Unmanned Photography, respectfully request that the FAA grant our exemption request and am willing to cooperate in sharing information to benefit the FAA, safety of manned aircraft, and the general public at large.

Sincerely,
Unmanned Photography



Brent M. Detter
Owner

Enclosure:
1. Appendix A IRIS+ Operation Manual
2. Appendix B FlySky ER9X Controller Operation Manual
3. Appendix C Unmanned Photography Standard Operating Procedures
4. Appendix D Unmanned Photography Flight Log

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Unmanned Photography

Appendix A

IRIS+ Operation Manual

IMPORTANT
Read before flying!

IRIS+ Operation Manual

3DR

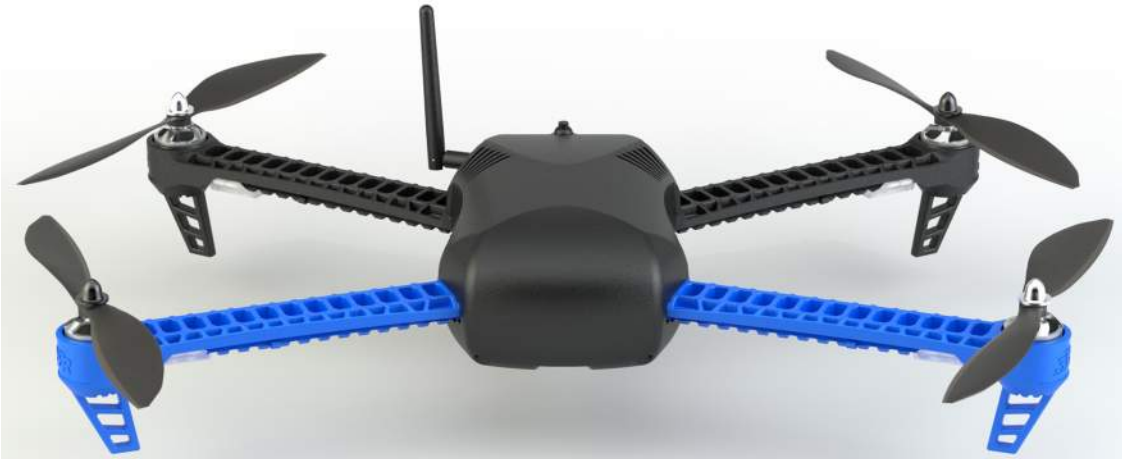
Contents

01 Meet IRIS
03 Parts
04 Charging the Battery
06 Attaching Propellers
07 Safety and Failsafes

08 Learn to Fly
11 Flight Modes
13 Return to Launch
13 Geofence
14 First Flight
19 Planning Missions
20 Flying Missions

21 Specifications and Resources
22 Learn More and Support

Meet IRIS+.



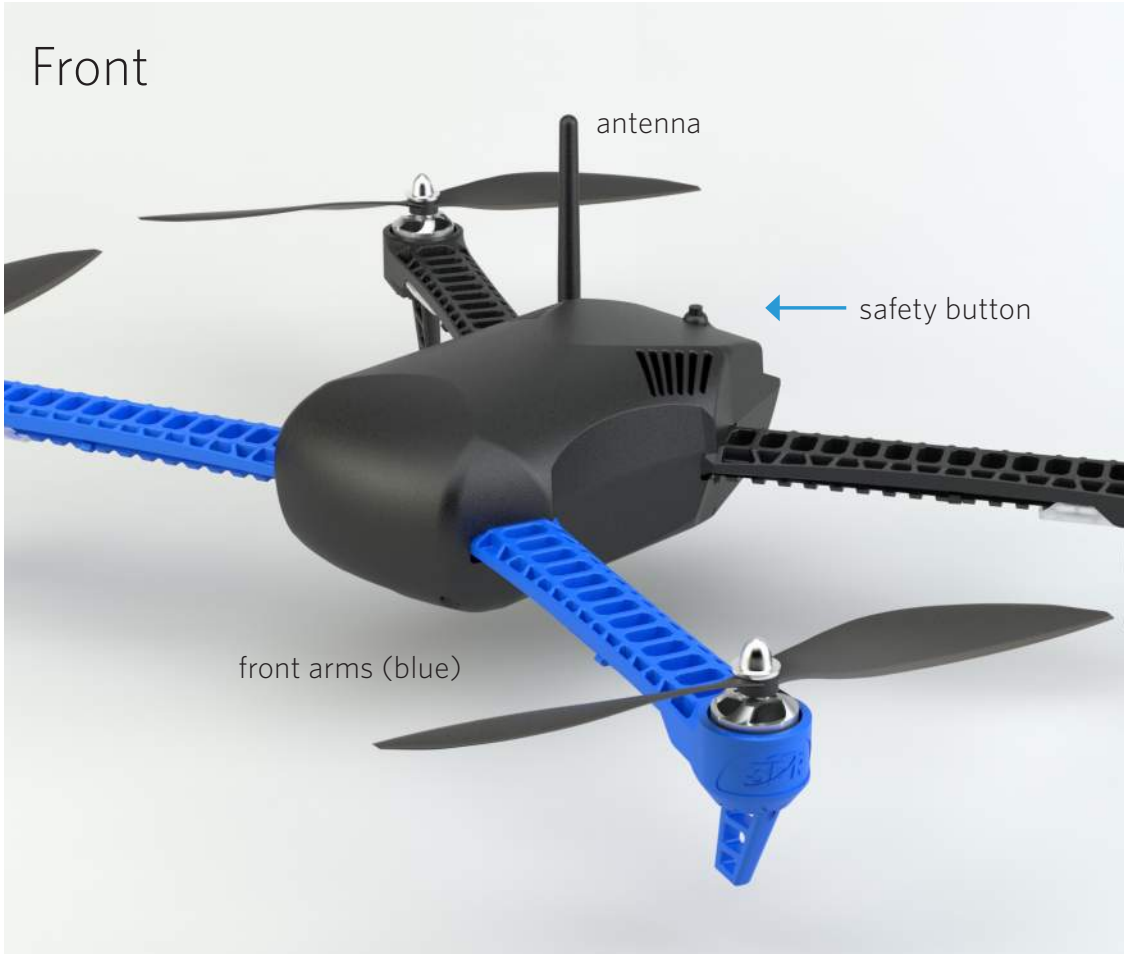
Thank you for purchasing IRIS+.

IRIS is a personal aerial imaging platform powered by open-source hardware, software, and firmware. Please read this manual carefully before your first flight and pay close attention to safety information.

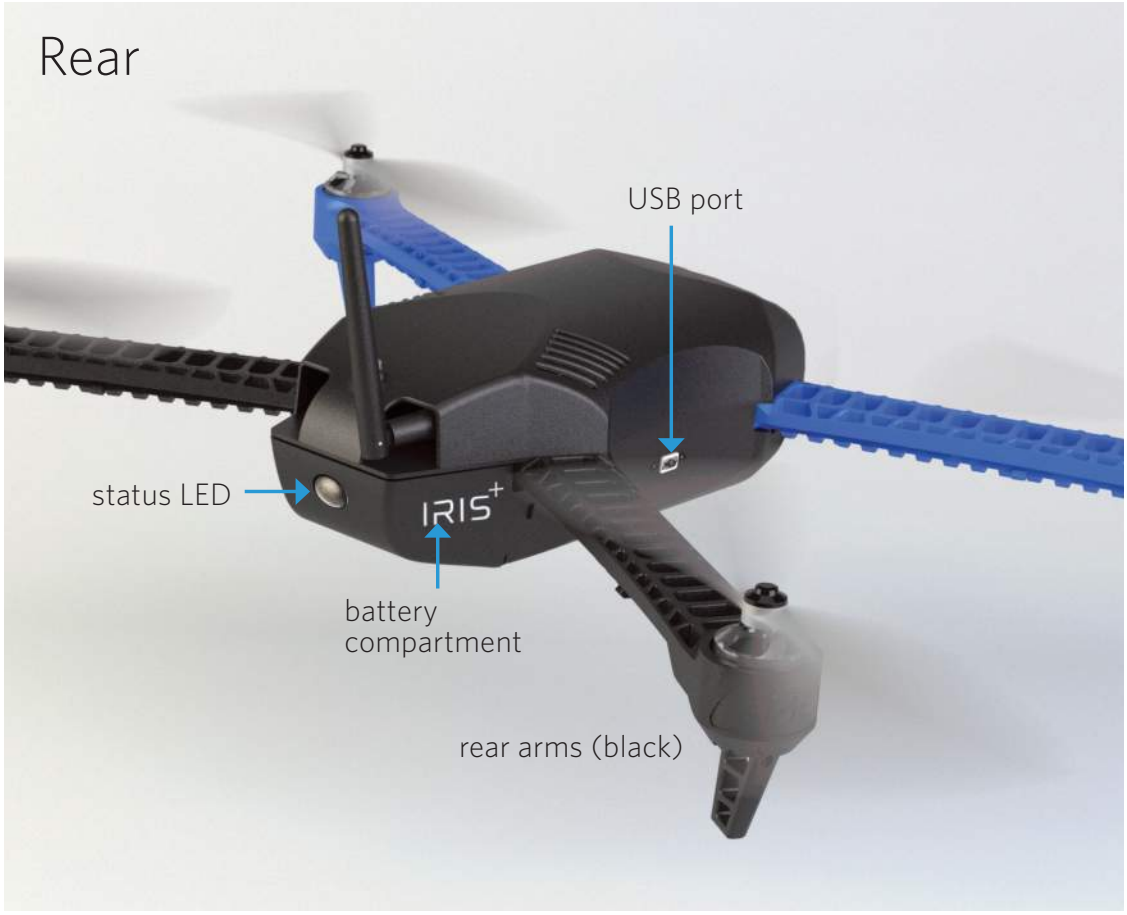
Happy flying!

Important note: When using a GoPro with IRIS, always ensure that the WiFi on the GoPro is turned **OFF**.

Front


antenna
safety button
front arms (blue)

Rear


USB port
status LED
IRIS+
battery compartment
rear arms (black)

Parts

Controller
your direct link to IRIS

Ground station radio
with USB and Android adapters

Battery kit
battery, guard bag, and charger
with international travel adapters

Propellers and tool kit
four propellers with propeller tool and
small, medium, and large hex keys
(1.5 mm, 2 mm, and 3 mm)

Tall legs
Switch to tall legs to use IRIS with the Tarot Gimbal or for extra clearance on landing.

Use the small (1.5 mm) hex key to loosen the set screw in the bottom of the leg.

Slide out the leg to remove it, and replace with the tall leg. Tighten the set screw until it sits flush with the surface. Do not tighten the screw beyond this point.

Charging the Battery

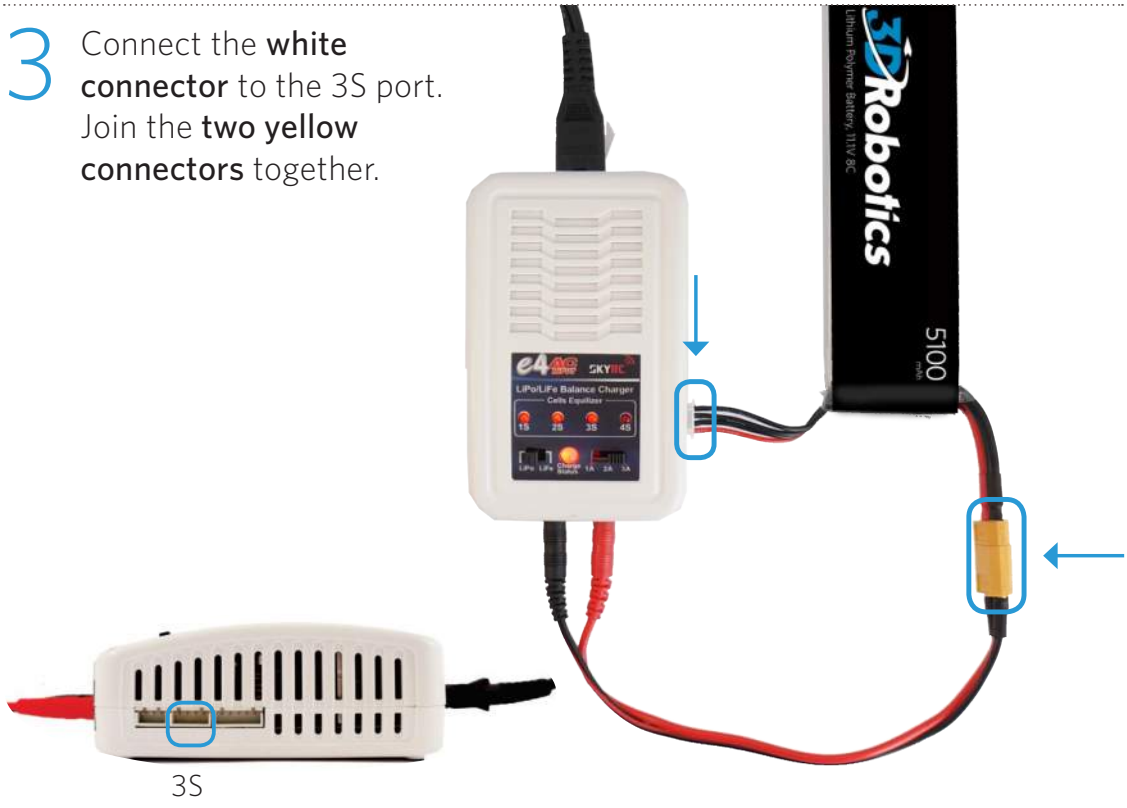
IRIS is powered by a rechargeable lithium polymer (LiPo) battery. Store the battery at half charge then charge fully before flying. Batteries must ship at half charge, so please charge before your first flight. Each full battery provides up to 22 minutes of flight time without a gimbal and up to 16 minutes when using a Tarot Gimbal.*

1 Connect charger to the power adapter cable and a wall outlet.

Connect the red cable to the + port and the black cable to the - port.

2 Set the charger to **LiPo** and **3A**.

3 Connect the **white connector** to the 3S port. Join the **two yellow connectors** together.



4 Secure battery inside the guard bag while charging. Charge until the status indicator displays green.

Charging **Complete**

Battery Safety

Protect the battery from extreme heat, extreme cold, puncturing, and flammable surfaces. Always transport, charge, and store the battery in the guard bag.

Charge the battery using a designated LiPo balance charger only. Always monitor the battery while charging.

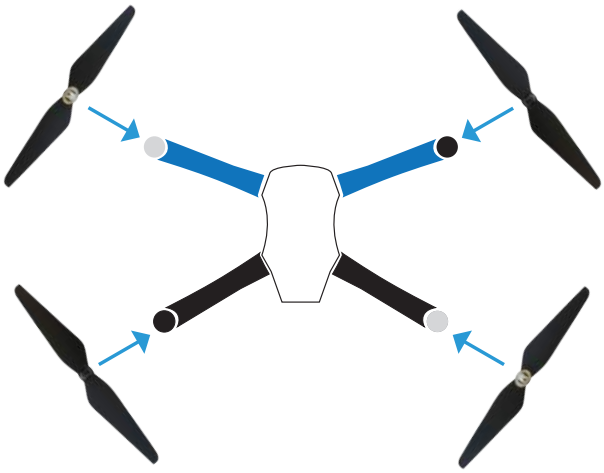
Flying with a low battery is a safety risk and can render the battery unusable. Always discontinue use when you receive a low battery notification, and always fly with a fully charged battery.

Inspect the battery for damage before takeoff and after landing. If you observe any swelling of the package or the battery ceases to function, locate your local battery recycling center to dispose of the battery. In the US and Canada, visit call2recycle.org to find a location. Do not dispose of the battery in the trash.

***Flight time varies with payload, wind conditions, altitude, temperature, humidity, flying style, and pilot skill. See the Flight Checklist for instructions on managing battery levels during flight.**

Attaching Propellers

IRIS uses four propellers: two with black nuts and two with silver nuts. Attach the propellers with black nuts to the motors with black tops and the propellers with silver nuts to the motors with silver tops.



Each propeller has locking and unlocking direction symbols. **To attach**, spin the propeller in the direction of the locking symbol. The propellers will automatically tighten onto the motors when you arm IRIS before takeoff.

For propellers with black nuts:

Spin clockwise to attach.

Spin counterclockwise to remove.

For propellers with silver nuts:

Spin counterclockwise to attach.

Spin clockwise to remove.

To remove, hold the motor in place with the propeller tool, and spin the propeller in the direction of the unlocking symbol.

Safety

IRIS has powerful motors and high-speed propellers. Never place your hands near propellers while IRIS is armed or the safety button displays solid red. Always press the safety button until it displays blinking red before handling.

Always fly in an open area away from people and buildings; do not attempt to fly indoors or in a confined space. Do not fly over people, near airports, or in any situation that could pose a hazard to those around you. Always fly within your line of sight and in compliance with local regulations. IRIS will not avoid obstacles on its own. As the operator, it is your job to recognize and avoid obstructions while flying. Always follow the preflight and postflight steps in the order described in this manual, and remain attentive at all times while flying.

Environmental factors, such as wind and GPS irregularities, can cause instability in flight. IRIS will attempt to compensate for these factors by triggering a failsafe if it detects an unsafe flying condition due to loss of controller signal, loss of GPS signal, or low battery (see below for details). To avoid potential hazards due to environmental factors, identify the boundaries of your flying area before takeoff, and recover IRIS manually by switching into standard (STD) if it moves outside your designated flying area. If you observe any inconsistent behavior, land, and consult the troubleshooting guide at 3dr.com/iris/info.

Failsafes

Loss of RC signal 

Always use the controller as a primary or backup control system when flying. Ensure that the controller is turned on any time IRIS is powered. If contact with the controller is lost during flight, IRIS will land and display a blinking yellow LED. If IRIS is more than 2 meters (6.5 feet) from the launch point, it will return to launch (RTL) before landing. (See page 13 for more information about RTL.)

Loss of GPS signal 

IRIS requires an active GPS signal before takeoff. If IRIS loses GPS signal in flight, it will trigger a GPS failsafe, indicated by a blinking blue and yellow LED with a high-high-high-low tone, and **automatically switch to manual control** (standard - altitude hold mode). Always be prepared to regain manual control of IRIS at any time while flying and choose an unobstructed flying area to improve GPS signal strength. When flying a mission, we recommended changing the GPS failsafe behavior to land. (Visit 3dr.com/iris/info for more information about configuring the GPS failsafe.)

Low battery 

When the battery reaches 25% of its remaining charge, IRIS will land and display a blinking yellow LED with a quick repeating tone. If IRIS reaches the low battery limit during a mission, it will return to the launch point before landing.

Learn to Fly

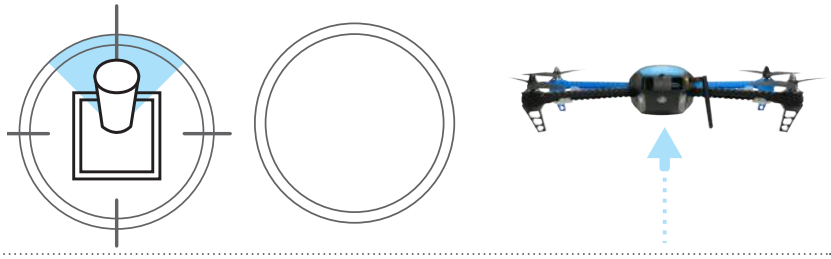
Maneuver IRIS in flight using the controller sticks.

Throttle

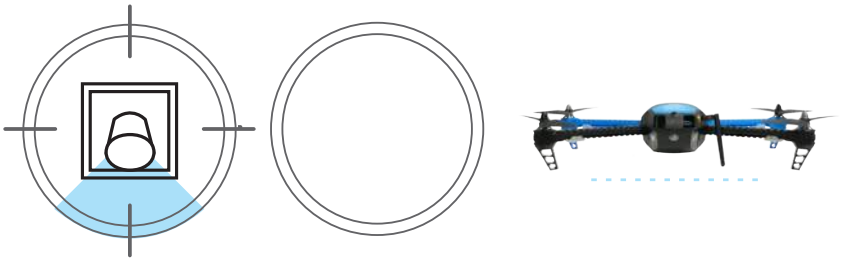
Move the left stick up and down to control altitude.

left stick

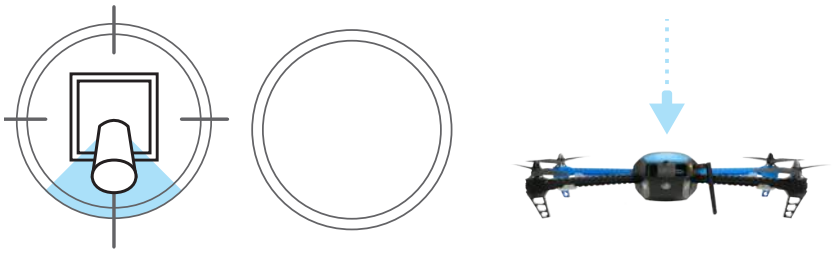
To take off and to gain altitude, raise the throttle stick slightly above center position.



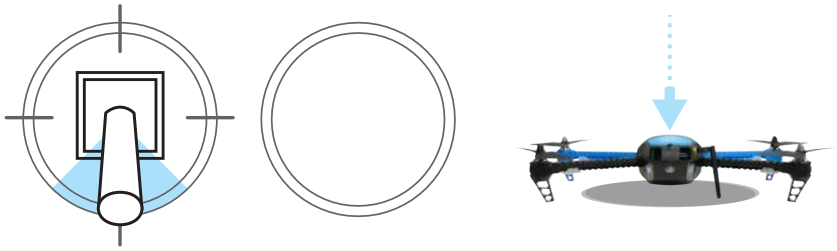
Set the throttle stick to center to maintain the current altitude.



Lower the throttle stick below center to decrease altitude.



Set the throttle stick fully down to land once IRIS is a few inches above the ground.

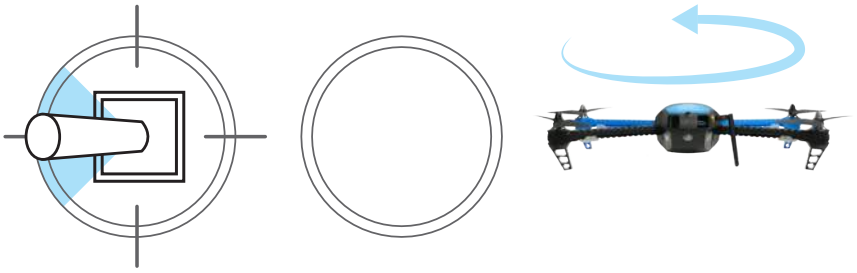


Yaw

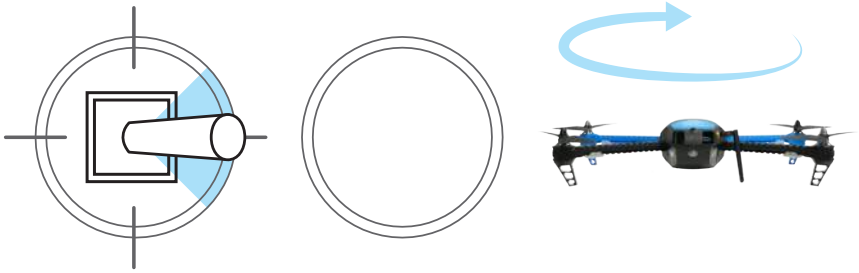
Move the left stick horizontally to rotate IRIS and change orientation. For a slow rotation, move the stick slightly away from the center in either direction. Moving the stick farther from the center creates a faster rotation.

left stick

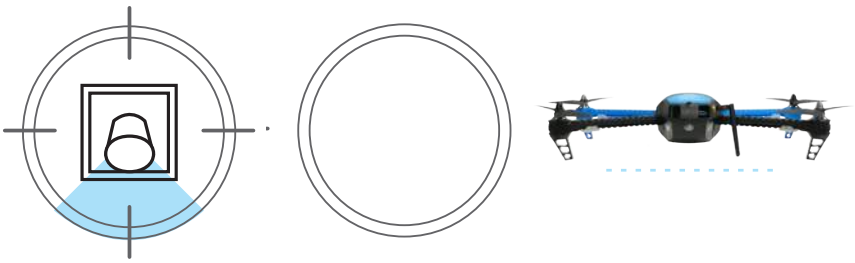
Move the stick to the left to rotate counterclockwise.



Move the stick to the right to rotate clockwise.



Release the stick to stop rotating and maintain the current orientation.



Flight Tip

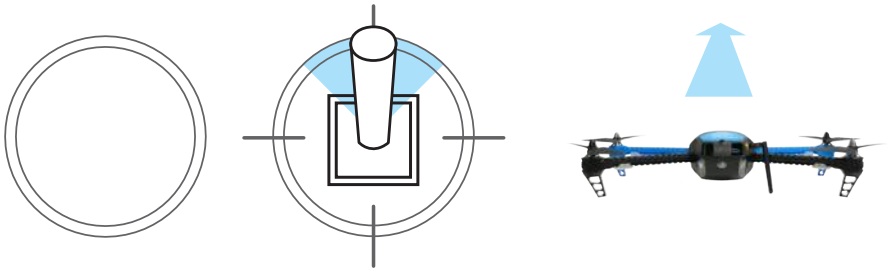
When adjusting orientation, move the left stick horizontally without changing its vertical position.

Pitch and Roll

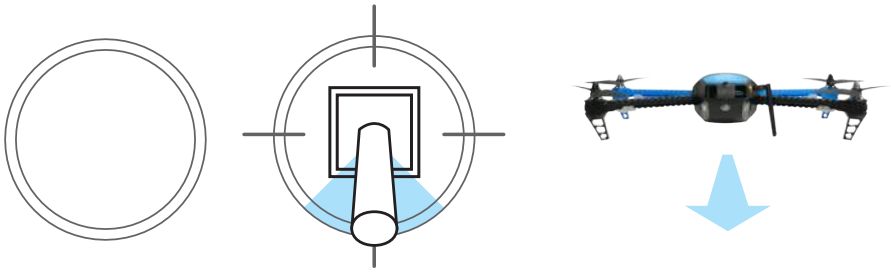
The right stick allows you to control IRIS' position in the air. Move the right stick to tell IRIS to move in that direction: forward (toward the blue arms), back (toward the black arms), left (toward the left arms), or right (towards the right arms). How far you move the stick from the center before releasing it tells IRIS how fast to move.

right stick

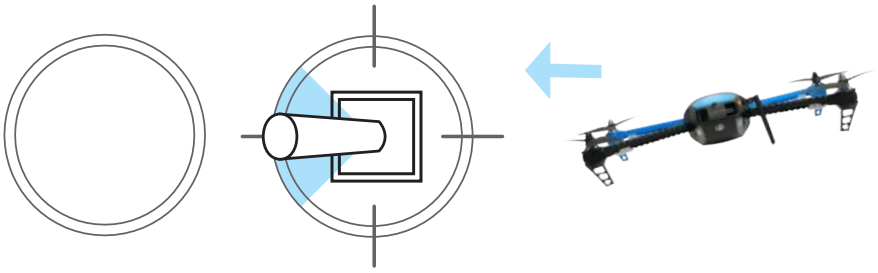
Move the right stick forward to fly forward.



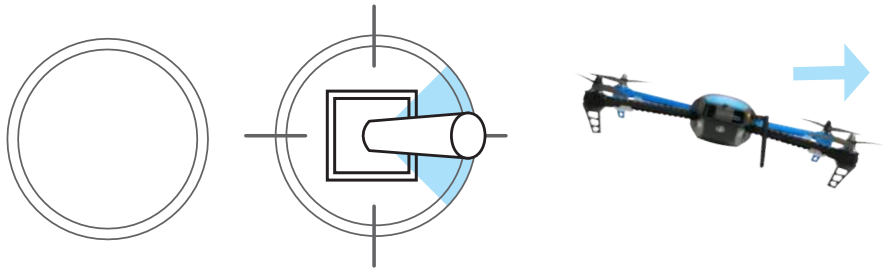
Move the right stick back to fly backward.



Move the right stick left to fly left.



Move the right stick right to fly right.



Flight Tip

IRIS moves according to its orientation. The blue arms and white lights face forward, and the black arms and red lights face backward. Before using the right stick, use yaw to keep IRIS facing in outward orientation so that the black arms and red lights face towards you and the blue arms and white lights face away from you.

Flight Modes

IRIS includes three flight modes: manual flight (STD-altitude hold), hover mode (LTR-loiter), and mission flight (AUTO). Use the switch on the right side of the controller to select a flight mode.

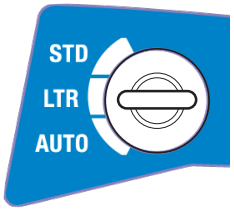
Standard (altitude hold mode)
STD

fly manually

Start your flight in standard to select altitude hold mode, and fly IRIS manually using the controller.

Loiter mode
LTR

hover



Select loiter to set IRIS to hover in place automatically. Use the controller to adjust IRIS' position then release the sticks to hold that position. Loiter is a great way for beginners to learn how to fly! If you're new to flying, start your first flight in loiter instead of standard.

To avoid sudden changes in altitude, set the throttle stick to center position before switching modes, including in the event of a GPS failsafe.

Advanced Operator Note: If you choose to modify the flight mode configuration to include Stabilize mode, please fly only with the provided set of tall legs. Flying in Stabilize with short legs can cause vibrations that may interfere with autopilot calculations and produce unexpected behavior.

Auto mode
AUTO

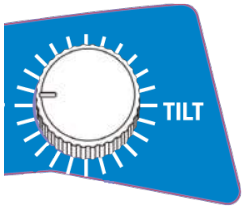
fly a mission

Select auto mode to fly an autonomous mission. IRIS will automatically fly the series of waypoints saved to the autopilot. See pages 19 and 20 for instructions on planning and flying missions.

Do not activate auto mode unless you have saved a mission to IRIS using a ground station application.

Gimbal control
TILT

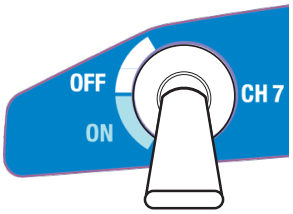
tilt the camera up and down



Connect a Tarot Gimbal (sold separately), and use the TILT knob to control the angle of the camera in flight. Visit **3dr.com/iris/info** for instructions.

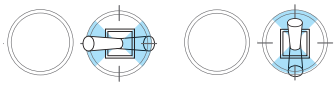
Land
CH 7

land at the current position

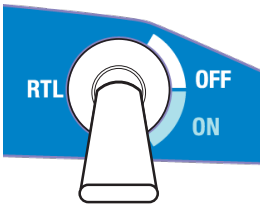


Set the CH 7 switch to ON to end your flight and land IRIS at its current position. Once you activate land, set the throttle stick fully down, and IRIS will automatically disarm after landing. IRIS will not disarm automatically unless the throttle stick is set fully down.

Reposition during landing: During landing, use the right stick on the controller to adjust IRIS' position.

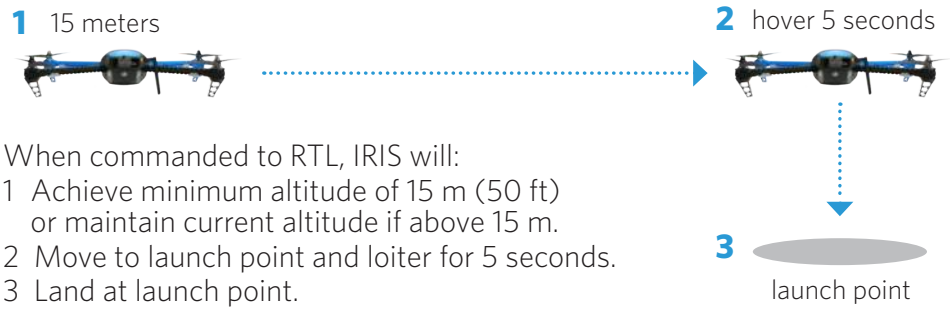


Return to Launch (RTL)



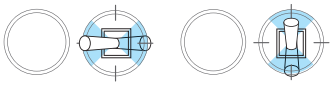
land at the launch point

Set the RTL switch to ON to end your flight and return IRIS to the launch point automatically. Ensure that the RTL switch is set to OFF before takeoff.



When commanded to RTL, IRIS will:
1 Achieve minimum altitude of 15 m (50 ft) or maintain current altitude if above 15 m.
2 Move to launch point and loiter for 5 seconds.
3 Land at launch point.

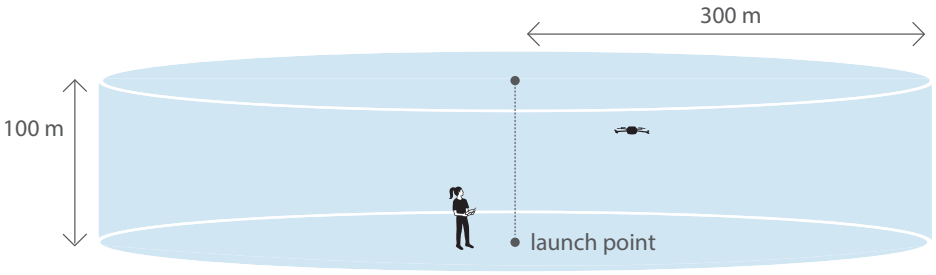
Reposition during landing: During landing, use the right stick on the controller to adjust IRIS' position.



RTL returns IRIS to the location where IRIS was armed. Always arm IRIS in a safe, unobstructed launch point.

Geofence

A safety fence restricts IRIS to within 300 meters (980 feet) of the launch point and under 100 meters (320 feet) in altitude. If IRIS reaches the edge of the geofence, it will initiate an automatic return to launch.



In the event of a GPS failsafe, the horizontal geofence will be disabled. If IRIS breaches the vertical geofence during a GPS failsafe, it will land at its current position.

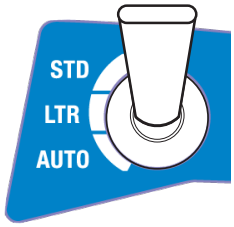
First Flight

Select an open area for flying, away from people and buildings, and remember to bring the Flight Checklist and a fully charged battery. Determine the boundaries of your flying area before takeoff, and select a level, unobstructed space as a launch point. Follow these preflight and postflight steps in the order shown here and on the Flight Checklist every time you fly.

Preflight

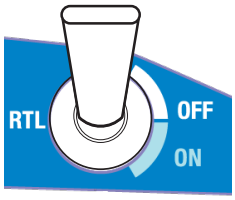
1 Check IRIS.

Point the controller antenna up and the IRIS antenna down for the strongest signal.



Set the mode switch to standard (STD).

If you're new to flying, try starting your first flight in loiter (LTR) instead of standard.



Ensure that the RTL switch is set to OFF.

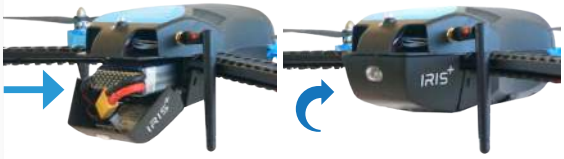
2 Power on controller.

Ensure that the controller is always turned on while IRIS is powered. If IRIS loses communication with the controller in flight, IRIS will initiate an automatic return to launch.

Press and hold the DN button on the controller to view flight data from IRIS. See the Flight Checklist for more information about controller flight data.

3 Connect battery.

Press the sides of the battery compartment together and rotate the door down.



Insert battery, and attach the yellow connectors. To close, squeeze the door, and rotate up until it clicks into place, ensuring that the battery cables do not interfere with the LED cables.

⚠

Keep IRIS still and level while it powers on and initializes the sensors.

Place IRIS at the launch point with the black arms facing towards you and the blue arms facing away from you.

Connect the radio to your ground station, and select Connect.

A ground station (recommended) lets you view live data in flight and unlock IRIS' advanced autonomous features. To download a ground station app for you laptop or Android device, visit 3DR.com/iris/info.

4 Press safety button.

Press the safety button until it is solid red.
IRIS is now live.

Stand back!

Do not handle IRIS while the safety button is solid red and IRIS is live. Always press the button until it displays blinking red before approaching the propellers.

Motors inactive, safe to handle

Motors active, deactivate before handling

5 Check LED.

Check the LED to view the status of IRIS. Wait to proceed until you see the blinking green light indicating that IRIS has acquired GPS lock.

Initializing, please wait.

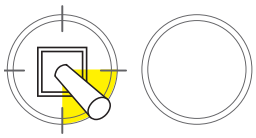
Acquiring GPS, please wait.

Autopilot ready, GPS locked

Pre-arm safety check failure. Connect to a ground station and see the trouble-shooting guide at 3DR.com/iris/info.

GPS lock requires a clear view of the sky. IRIS may take a few minutes to acquire GPS lock depending on your flying location. Always fly in an open area to improve GPS signal strength, and review the GPS failsafe information on page 7.

6 Arm motors.

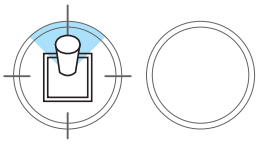


To activate the motors, hold the left stick down-right until the motors spin.

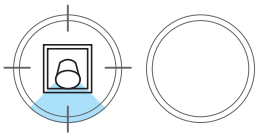
Now you're ready for takeoff!

IRIS will spin its propellers when armed. Ensure that the launch point is clear of obstructions before arming. Always disarm the motors before approaching IRIS.

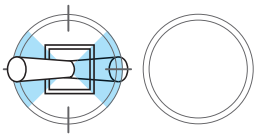
Flight



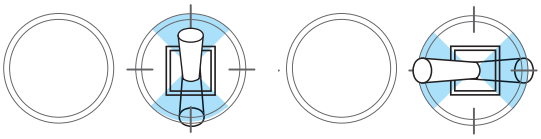
Take off and gain altitude by raising the left stick slightly above center.



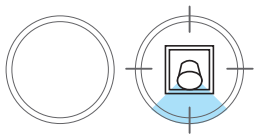
Set the left stick to center to maintain the current altitude.



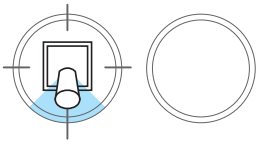
Rotate counter-clockwise and clockwise by moving the left stick left and right.



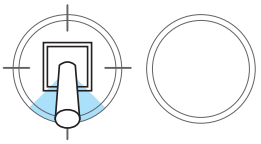
Fly forward, backward, left, or right by moving the right stick in the direction you want to fly.



Release the right stick to level IRIS.



Lower the left stick below center to descend.

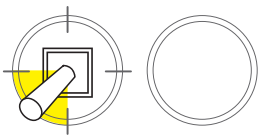


Set the left stick fully down to land once IRIS is a few inches above the ground.

IRIS is a powerful and agile flier. Move the sticks in small increments until you feel comfortable with how IRIS responds to controls.

Postflight

1 Disarm motors.



After landing, hold the left stick down-left until the motors stop spinning.

2 Press safety button.

Press the safety button until it displays blinking red to make IRIS safe to handle.

3 Disconnect battery.

4 Power off controller.

Your first flight is now complete!

Follow the steps shown here and on the Flight Checklist every time you fly.

Tips for New Fliers: Practice these exercises to help you master flight controls.

Skill 1: Hover
Your first step is to maintain a consistent altitude while keeping IRIS oriented so the black arms face towards you and the blue arms face away from you. Practice taking off, rising to a comfortable hovering altitude, and keeping IRIS in place without allowing for any changes in orientation or position. If IRIS drifts forward, backward, left, or right, or rotates clockwise or counterclockwise, use the corresponding stick controls to correct.

Skill 2: Box
When you feel comfortable with your ability to maintain a consistent hovering altitude, try flying a box pattern. To practice this, take off, reach your hovering altitude, then fly forward, right, backward, and left by making small adjustments to the right stick. Make sure to fly the box in front of you and not around you. Use the left stick to rotate IRIS so the black arms face towards you and blue arms face away from you for the duration of the exercise.

Skill 3: Figure Eight
When you can confidently navigate a box while maintaining altitude and orientation, try flying a figure-eight pattern. Once again, make sure to fly the figure eight in front of you and not around you. Use the right stick to create a smooth flight path while using the left stick to correct orientation and maintain altitude.

Planning Missions

To plan a mission, download a ground station application from **3dr.com/iris/info**, and install onto your laptop or Android device.

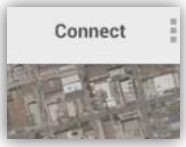
DroidPlanner 2 for Android

Mission Planner for Windows

APM Planner for OS X

1 Power IRIS, connect the radio to your laptop or Android device, and select Connect.

Connect the blue end of the Android adapter to your device and the black end to the radio. Select Connect.



Connect the USB adapter to the radio and your laptop. Select AUTO, 57600, and Connect.

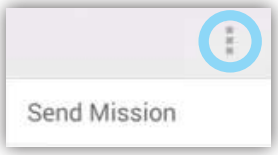
2 Configure waypoints.

Select Edit and tap to add waypoints, or select the brush tool and draw a path for IRIS to follow.

Select Flight Plan, and click to add waypoints. Select the green arrows at the bottom of the screen to configure altitude and change waypoint types.

3 Save the mission to IRIS.

Select the option menu in the top-right corner, and select Send Mission.



Select Write WPs.

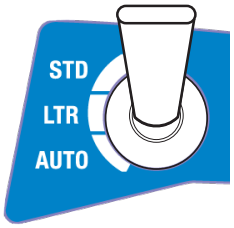
When flying missions, we recommend changing the GPS failsafe behavior to set IRIS to land in the event of a loss of GPS signal. For instructions, visit 3dr.com/iris/info.

Flying Missions

1 Perform a pre-mission test flight.

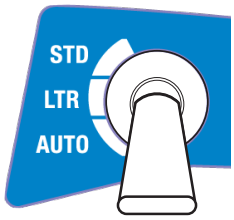
Fly a brief test flight to verify that all controls (throttle, yaw, roll, and pitch) are responding normally.

2 Arm IRIS in standard.



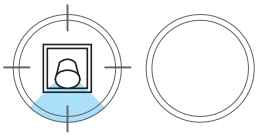
When you're ready to start the mission, arm IRIS in standard (STD).

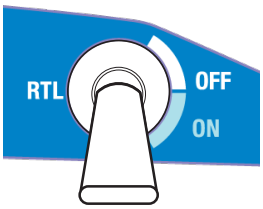
3 Switch to AUTO.



If you planned a takeoff waypoint into your mission, switch to AUTO on the ground, and **raise the throttle to initiate the mission.** If you did not add a takeoff waypoint, switch to AUTO mode after takeoff to initiate the mission in flight.

For auto-takeoff, raise throttle to start mission.

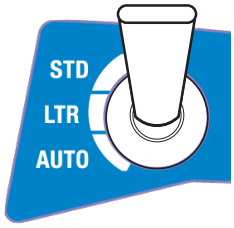




To recall IRIS during a mission, use the controller to switch to standard (STD) and land manually. Or switch to RTL, and automatically return to the launch point.

To avoid sudden changes in altitude when switching from auto to standard (STD), ensure that the left stick is set to the center position.

4 Switch to standard before disarming.



When the mission is complete and IRIS has landed, use the controller to switch to standard (STD) then disarm and proceed with the postflight steps.

If you added an automatic landing waypoint to your mission, IRIS will disarm automatically after landing.

Specifications

Autopilot:	Pixhawk v2.4.5
Firmware:	ArduCopter 3.2
GPS:	3DR uBlox GPS with Compass (LEA-6H module, 5 Hz update)
Telemetry radio:	3DR Radio Telemetry v2 (915 mHz or 433 mHz)
Motors:	920 kV
Frame type:	V
Propellers:	9.5 x 4.5 T-Motor multirotor self-tightening counterclockwise (2) 9.5 x 4.5 T-Motor multirotor self-tightening clockwise (2)

Battery:	3S 5.1 Ah 8C lithium polymer
Low battery voltage:	10.5 V
Maximum voltage:	12.6 V
Battery cell limit:	3S

IRIS is compatible with 3S lithium polymer batteries only.
Using a 4S battery can cause permanent damage to the gimbal electronics and will void the warranty.

Payload capacity:	400 g (.8 lbs)
Radio range:	up to 1 km (.6 miles)
Flight time:	16-22 minutes, depending on payload

Resources

Hardware:	3dr.com/iris/info
Firmware:	copter.ardupilot.com
Software:	planner.ardupilot.com and planner2.ardupilot.com
3DR Store:	store.3dr.com
Community:	diydrones.com

Happy flying!

Learn More

Visit **3dr.com/iris/info** to learn about:
- 3PV™ Follow Me and DroidPlanner
- Opening the shell
- Replacing the arms and motors
- Installing software
- Planning a mission
- Updating firmware
- LED meanings and tones

Visit **copter.ardupilot.com** to learn about:
- Additional flight modes
- Configuring parameters, including yaw behavior during autonomous flight, descent speed during RTL, and more

Visit **planner.ardupilot.com** (Mission Planner) and **planner2.ardupilot.com** (APM Planner) to learn about:
- Planning a mission with waypoints and events
- Using a ground station to command IRIS in flight
- Downloading and analyzing flight logs

Join the community and share your experience at **diydrones.com**.

Follow us on Facebook and Twitter **@3drobotics**.

Support

For customer support, contact us at **help@3dr.com** or call our support line at **+1 (858) 225-1414** Monday through Friday, from 8 am to 5 pm, PST.

3DR

Unmanned Photography

Appendix B

FlySky ER9X Controller Operation Manual


FS TH9X

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The IMAX/FLYSKY/TURNIGY/EURGLE 9x is a computerized radio from china. The transmitter is outfitted with a 128x64 pixel monochrome LCD, 2-2axis gimbals, 3 variable potentiometers (pots), 6 2-position switches, 1 3-position switch and some funky red trim.

The big thing about this transmitter is the price. At the time of writing radios may cost anywhere from $180 for simple units up to $1000+ for super blinged out bazillion channel super heavyweight monsters.

This one costs $60.

Where's the catch then? (you ask) The catch is in the software (firmware - FW). The original FW is less-than-perfect. It has bugs, funky navigation and the most annoying beeping I have ever heard. Not good.

However, some neat guy called Thus figured out that the whole radio is made from gimbals, switches, funky trim and a very generic main processing unit that does absolutely everything. He had one of those ah-ha moments where insanity overrides common-sense and decided to completely rewrite the original software and replace it with his own.

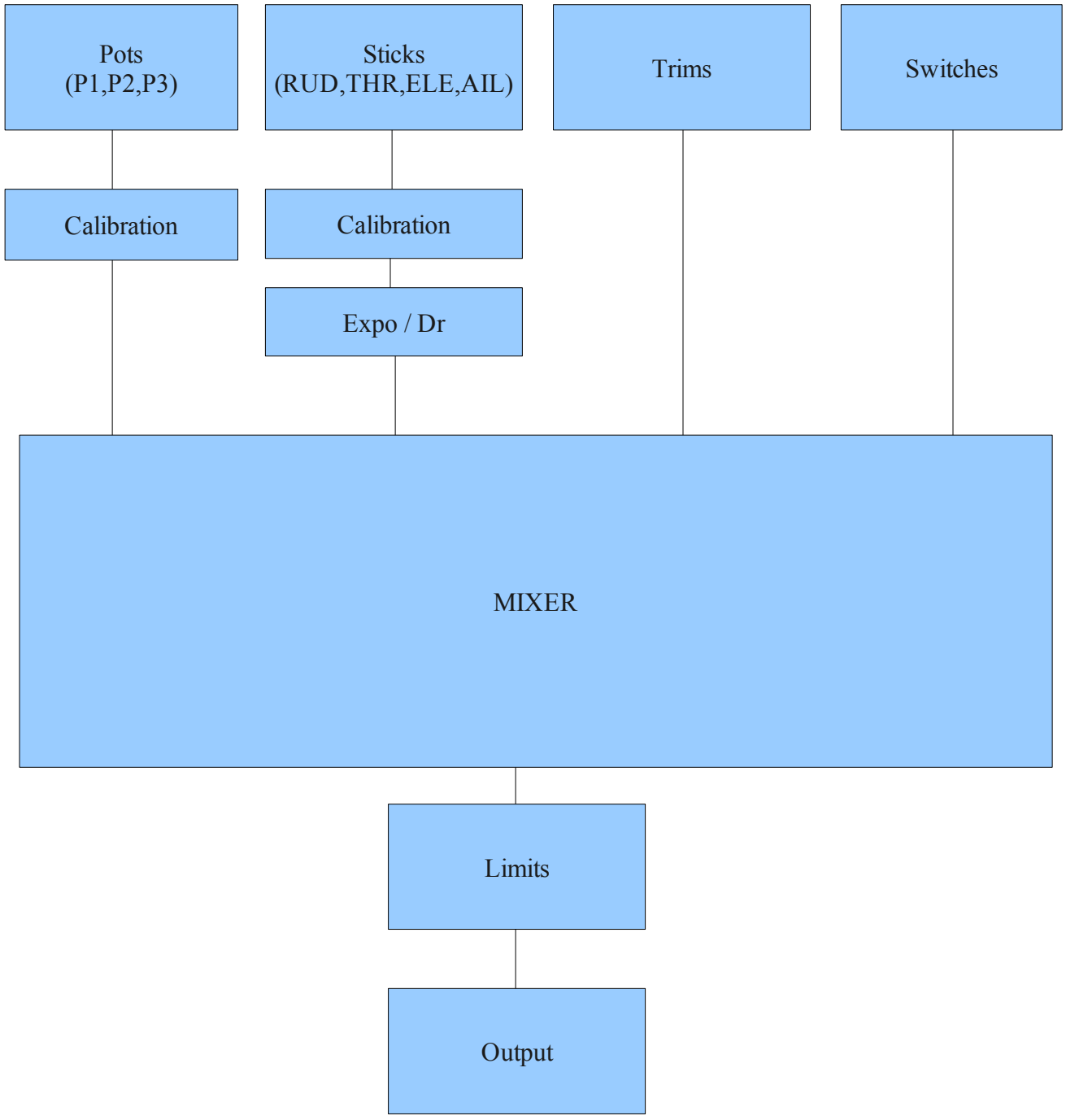
At some point I decided that while Thus' FW is great I really wanted more bling for my TX. So in the spirit of open-source Thus' source was stolen and ER9x was born. (Yah, I was vain. ER are my initials)

You might want to check out Thus' code – it's available here: http://code.google.com/p/th9x/

While you're at it check out RadioClone's code – which also runs on the 9x. While ER9x is based on Thus' code, I have managed to pilfer some of RC's excellent code. His FW is more complex but also more powerful. Check it out here: http://radioclone.org/

Got you all worked up about this? Good. Go now to the kitchen, make yourself a nice cup of coffee. This is a long read. I'll wait here till you're ready. Promise!

Bear with me here – some flow charts coming up:



What the heck was that?
The system receives 4 types of imputs:

1. Main Sticks
2. Potentiometers
3. Trims
4. Switches

The analog inputs (sticks and pots) go through a calibration phase. The sticks can also go through Expo and Dr filters before going to the mixer.

The mixer does it all. It directs each input to the desired output (CH1..CH16). It controls how the inputs are added. It also controls the timing of each function.

After the inputs are processed by the mixer they are directed to the relevant output channels. The limit procedure takes over and makes sure no output goes too far.

Finally the channels are encoded and sent to the RF module to take that nice little hike through the air to your model.

(just so we understand each other)

Inputs:

1. RUD – Rudder.
2. ELE – Elevator.
3. THR – Throttle.
4. AIL – Aileron.
5. P1/P2/P3 – Pots.
6. Switches:
    1. THR – Throttle cut switch, don't confuse this with the THR stick. The THR switch is located on the back left side.
    2. RUD – Rudder Dr switch.
    3. ELE – Elevator Dr switch.
    4. ID0, ID1, ID3 – Three position switch. These 3 define the 3-position switch. ID0 is the top position, ID1 – mid position and ID2 – bottom position.
    5. AIL – Aileron Dr switch.
    6. GEA – Gear switch.
    7. TRN – Trainer switch. This switch is spring loaded.
    8. SW1..SW6 – Custom switches. More on these later.

It should be stated that every function in this FW is assignable. There are no fixed switches. You can choose the TRN switch to be throttle cut and use the triple switch to control Dr. The names are useful since they are labeled like that on the Tx.

There are 6 edit buttons on the Tx. In this manual they are noted with square brackets ([MENU]). Some functions need the button to be pressed and held for a second or so. The are noted as “long” presses like so: [MENU LONG]

Also since the “+” and “-” keys are placed stupidly in the original Tx I've switched their position. So [+] is actually [-] and vice-versa. This is actually more intuitive than the original (trust me, I've tried using them as is).

Since to upload this FW you need to open up your Tx and do some modifications (which void your non-existent warranty FYI) it is highly recommended you switch between the [+] and [-] keys. It's a simple job, so don't skimp, you'll thank me later.

To avoid confusion with people who modded their keys and all the others I'll refer to the [+] and [-] keys as [LEFT] and [RIGHT] from now on. (I hope that left and right are still universal values – you can never tell today)

The “!” sign. Whenever you see the “!” sign you can read that as “not” or “inverted”. Switches can be “normal” or “inverted”. So when choosing the elevator d/r switch ELE is normal operation and !ELE denotes inverted operation.

As a general rule the [UP]/[DOWN]/[LEFT]/[RIGHT] move the cursor appropriately The [MENU] key is used for selection and for editing. The [EXIT] key is used for exiting (surprise). Pressing [EXIT] will generally bring the cursor to the top of the screen. Another press will exit the menu to the main screen. Pressing [EXIT LONG] will exit immediately to the main screen.

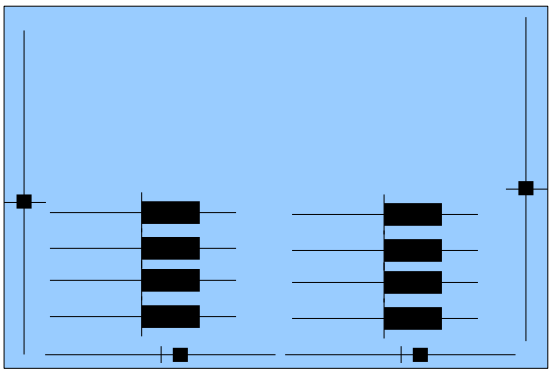
Pressing [MENU] from the main screen will take you back to the last menu.

From the main screen you can press [RIGHT LONG] to enter the model setup pages. Pressing [LEFT LONG] will enter the general setup menus.

Once in the menus you can navigate between different screens using the [LEFT]/[RIGHT] keys as long as the cursor is at the top right position of the screen.

As a rule once a value is changed it is saved. You can turn off your Tx and turn it back on and the values will be saved. The values are saved internally in the MCU's eeprom. However there is a slight delay sometimes so it's probably a good idea to wait a couple of seconds before turning off.
There is no undo functionality. Once something is erased/changed it's changed for good.

Generally, when a value is highlighted and you cannot move left or right then pressing [LEFT]/ [RIGHT] will change that value.
When moving left or right is possible you need to press [MENU] to edit that value. Edit-mode is displayed by the cursor blinking. To exit edit-mode press either [MENU] or [EXIT].



(Cool back light here, huh?)

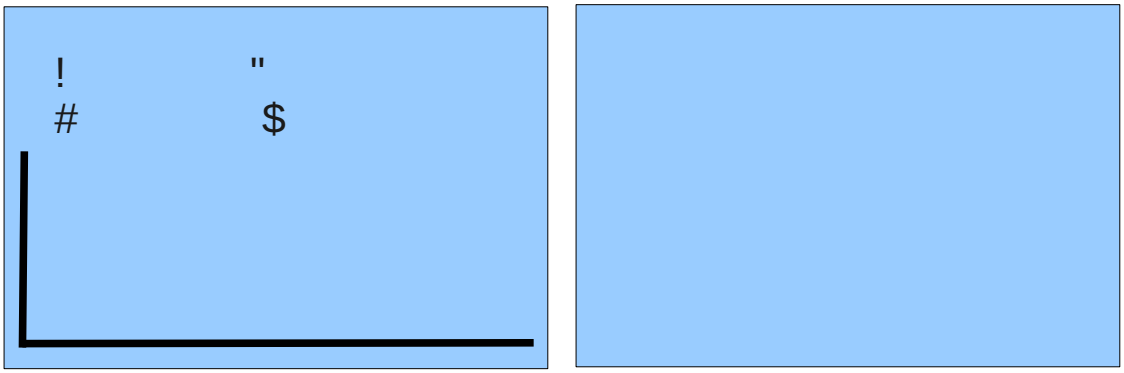
The main view is split into top and bottom. The top contains the following:

The current model's name. (goofi in this case and yes, it's a real airplane)
The battery voltage.
Trim increment information.
Timer and timer trigger information. Pressing [EXIT LONG] resets the timer.
Throttle trim activation information.

The bottom consists of three screens. You can flip between these with the [UP]/[DOWN] keys.

The 3 screens are:

Value bars – these show the output values for the first 8 channels.
Value values – The output values for the first 8 channels.
Input values – Stick position and switch indicators.



From the main screen pressing [UP LONG]/[DOWN LONG] will enter the statistics screen.

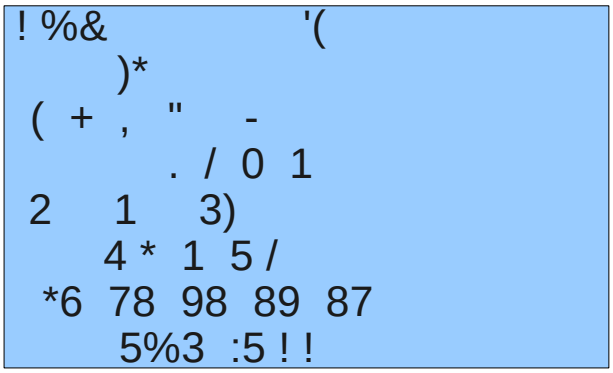
The first shows some available timers and traces the throttle stick as well.

The second shows general timing of the Tx. The value “tmain” shows how long the math takes. This will increase as you add more mixers. It can be very large sometimes depending on eeprom writes. You can reset the timers by pressing [MENU].

From the main screen pressing [LEFT LONG] will enter the general settings menus. Here you can set up settings that will be the same regardless of chosen model.

The menus are as follows:

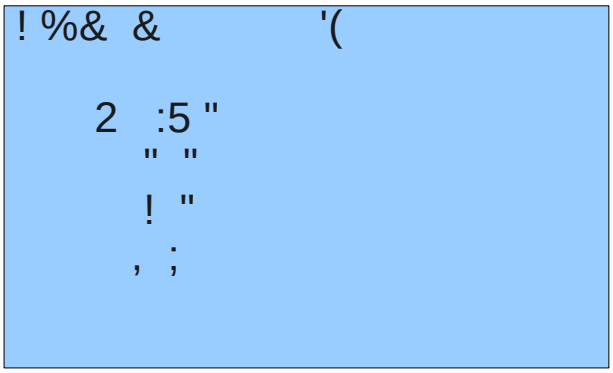
1. Basic Setup
2. Setup Options
3. PPM In Calibration
4. Version Information
5. Diagnostics
6. Analog Inputs
7. Calibration



Use this screen to set up general functions for the Tx:

1. Contrast: The LCD's contrast. The values can be 20..45.
   The higher the value the darker the screen.
2. BAT Warning: Battery voltage warning. When the connected battery's voltage drops below this voltage the Tx will beep. Though the Tx will continue to function normally it's really advisable to land as it is known that this FW was not able to fix the “zero voltage non-functionality” problem of the original.
3. Inactivity Alrm: This will set up a warning that will beep if the Tx is left unattended for the specified amount of time.
   Values can be from 1 to 250 minutes. To reset the timer simply move one of the sticks.
4. Filter ADC:
   i. SING: Single conversion. This is the fastest conversion but base resolution is 1024.
   ii. OSMP: Oversampling. This uses extra samples to increase resolution to 2048. Just slightly slower than SING.
   iii. FILT: Filtered. This is in case you have excessive noise from the conversion (servo jitters). This will filter the input and prevent that noise. It will, however, increase latency by ~30msec.
5. Throttle Rev: This is for all you wacky people who fly with the throttle backwards (e.i. idle is far from you and full is close to you). Though I personally don't understand how you fly like that it's a nice feature.
   The reverse will also reverse the throttle warning on startup and some other throttle related functions.
6. Light: This chooses a switch which can be used to turn on a backlight if connected.
7. Mode: Choose between MODE1, MODE2, MODE3 and MODE4.

!



Startup warnings here:

THR Warning: If ON will show a warning when throttle is not at idle when the Tx is turned on. The Tx will not output a signal until the alert is cleared.

SW Warning: If ON will show a warning when the switches are not at the default position when the Tx is turned on. The Tx will not output a signal until the alert is cleared.

MEM Warning: If ON will show a warning when the available eeprom memory is less than 200 bytes when the Tx is turned on. The Tx will not output a signal until the alert is cleared.

Beeper: Sets Beeping levels

I. 0 – Quiet. No beeping at all. No warning – nada. If the kids are sleeping and you must setup the model in your living room this is the mode to use. Just remember that the Tx will not even warn you when the battery is low. If you're using a Lipo watch out!
II. 1 – No keys. The beeps are normal but edit keys are silent.
III. 2 – Normal. Normal beeping.
IV. 3 – Extra long beeps. For those who want to annoy other people.

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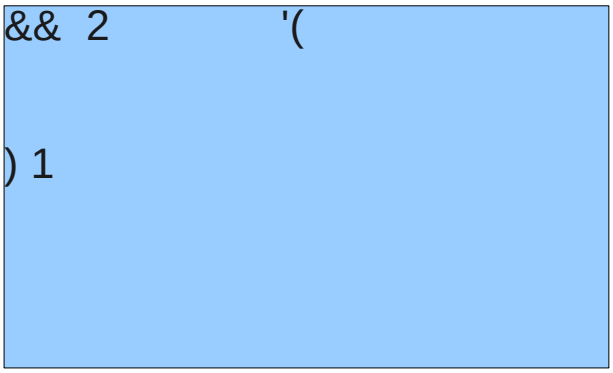

This menu allows you to calibrate the mid point for the input PPM channels.

Highlighting “Cal” and pressing [MENU] will calibrate the mid point for all PPM IN channels.

PPM IN is read from the signal at the trainer port of the Tx.

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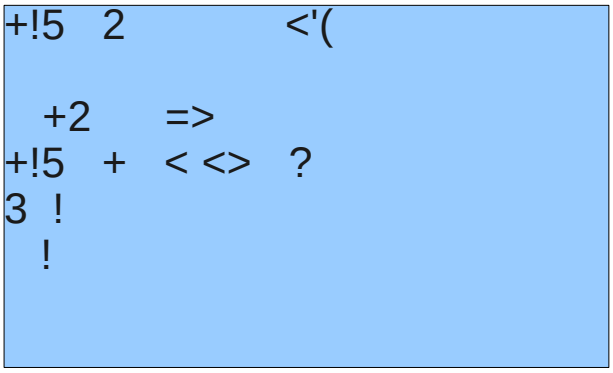

This screen shows the version information for the current FW:
SVN: The SVN name of the current revision.
DATE: Compile date for the current FW.
TIME: Compile time for current FW.
VERS: Version number.

Since ER9x is OPEN SOURCE I try to help out anyone who has problems. Please feel free to open new issues for defects and/or enhancement requests at the project's code page:
http://code.google.com/p/er9x/issues/list

Your participation is what helps me makes the FW better. Please use the revision number stated in this screen when you state a problem.

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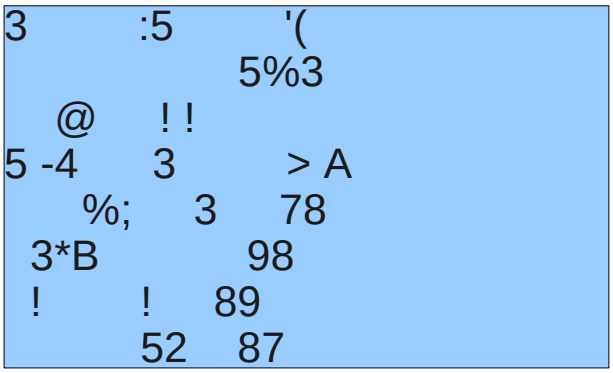

This menu will help you visualize the current state of the trims, keys and physical switches.
Each Key/Switch/Trim is represented. When pressing a key or switch they are highlighted.

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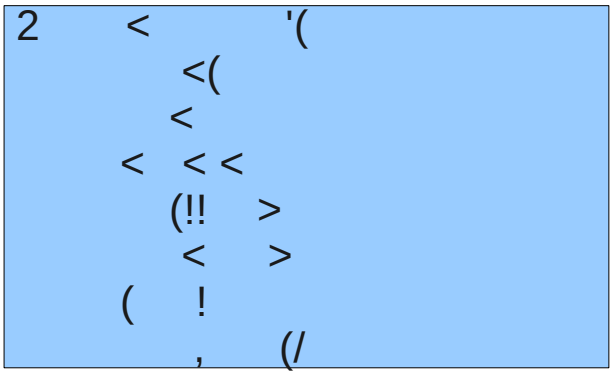

Here you can see the analog inputs in hexadecimal format to save space and annoy you at the same time.
Values range between 0..0x3FF (0..1023).

A1..A4 are the gimbals (sticks).
A5..A7 are the pots.
A8 is battery voltage. You can press [DOWN] and highlight the battery voltage. Pressing [LEFT]/[RIGHT] will increase and decrease the value and so enable you to calibrate the battery voltage monitor.

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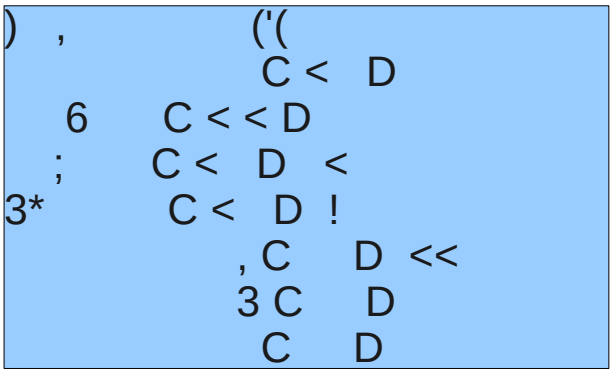

This screen allows you to calibrate the analog channels (A1..A7).

The calibration method goes like this:

1. Press [DOWN] → (SetMid)
2. Set Sticks to center. (Including throttle)
3. Press [DOWN] → (SetSpan)
4. Move sticks and pots through full range.
5. Press [DOWN] → (Done) – Values are saved here.
6. Press [DOWN] (Back to top)

The values are calculated when you press [DOWN].
They are saved when you press [DOWN] to (Done).
(Works surprisingly well for a cheap Chinese Tx)

From the main screen pressing [LEFT RIGHT] will enter the model select/settings menus. Here you can set up settings that model specific.

The menus are as follows:

1. Model Select
2. Model Setup
3. Expo/Dr
4. Mixer (This is the important one)
5. Limits
6. Curves
7. Custom Switches
8. Templates

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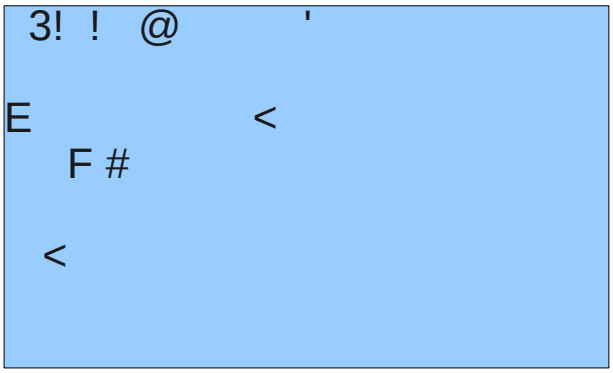

In this screen you can see, select, copy and move models between different memory “slots”. I quote the word “slots” because memory management is dynamic. The available memory is displayed at the top of the screen.
Memory usage for each model is displayed on the right. The more complex your model (mixes/curves/options/limits/etc) the more memory it'll take.

The “*” on the left shows the currently loaded model memory.
Pressing [UP]/[DOWN] will move the cursor between different models.

Pressing [MENU] will highlight the model. Pressing [UP]/[DOWN] with the model highlighted will move it up/down. Pressing [MENU] again will copy the model memory. Pressing [EXIT] will only move it.

Pressing [EXIT] will load the highlighted model.
Pressing [EXIT LONG] will load and exit to the main screen.
Pressing [MENU LONG] or [RIGHT LONG] will load the model and go to the next screen (Model Setup).

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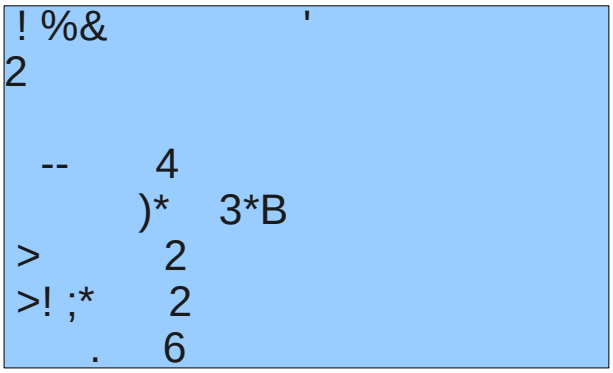

Lots of options here:

1. Name: Unsurprisingly here you edit the model's name. To edit: scroll down until the name is highlighted and press [MENU].
   Once your press [MENU] only one letter will remain highlighted. To change the letter you press [UP]/[DOWN]. To move the cursor press [RIGHT]/[LEFT].
   Once done, press [MENU]/[EXIT] to exit the edit.
2. Timer: Here you set the value for the timer.
   Press [RIGHT]/[LEFT] to choose between minutes and seconds.
   Press [MENU] and the cursor will blink. To edit use the [UP]/[DOWN]/[RIGHT]/[LEFT] buttons and [MENU]/[EXIT] when done.
3. Trigger: Choose what triggers the timer → (remember – by pressing [LEFT] you'll see the same values with the "!" sign. This means that the usage is inverted)
   1. OFF – timer is off.
   2. ABS – timer is on.
   3. RUs/RU%/ELs/EL%/THs/TH%/ALs/AL% - chooses to activate the timer based on stick position. When a XXs is selected (THs for example) The timer starts whenever the stick is not at zero.
      The XX% sign is the same except the timer speed is determined by stick position. When at zero, the timer is stopped. When at full the timer goes at normal speed. When midway the timer's speed reflects the sticks position.
   4. Switches – You can specify a switch so whenever that switch is activated the timer counts.
   5. Momentary switches. A switch denoted with "m" (like TRNm) means "momentary". That means that moving the switch once to the on position and back turns the timer on. Moving it on and off again turns the timer off. (difficult I know, take a sip from your coffee, relax a bit, take a break – it's not difficult once you try it out :))
4. Timer: Here you can choose whether the timer counts up or down.
5. T-Trim: Throttle trim. This is a nifty feature for power fliers. When activated a couple of things happen. First off the center detent for the throttle trim is removed. Also the throttle's trim will now only affect the "low" side. That means you can use the trim for setting idle while full throttle remains unchanged.
6. T-Expo: 'nother throttle related function. This one makes the throttle stick's expo go from zero to full instead of having a center like all the others. Always the odd kid out this throttle is.
7. Trim Inc: Trim increments:

    1. Exp – Exponential. With this the trims are fine near the center and get progressively coarser farther out.
    2. ExFine – Extra fine – 1 step per click.
    3. Fine – 2 steps per click.
    4. Medium (my personal favorite) – 4 steps per click.
    5. Coarse – 8 steps per click.
8. Trim Sw: Neat little function this is. When in flight if this key is activated it reads the current position of the sticks and trims and copies that into the subtrims. After that it zeros the trims. This is really neat for new models when you might have a hard time taking your hands off the stick and pressing the trims. Simply hold the plane level with the sticks and press the selected trim switch. Voilà – the plane is trimmed. It's magic! No it ain't. It's ER9x!!!
9. Proto: encoding protocol
    1. PPM – with ppm you can choose how many channels to encode. Anything from 4 to 16 channels. You can also change the pulse spacing. This is useful for systems which might experience jitter. On the whole it might be a good idea to leave it alone.
    2. Other protocols include Silver A/B/C and TRAC09.
    3. TRIM->subTRIM [MENU]: Pressing [MENU LONG] here will copy the trims to the subtrims and zero them.
    4. DELETE MODEL [MENU]: Guess....
       This deletes the current model. You need to press [MENU LONG] for that to happen though.

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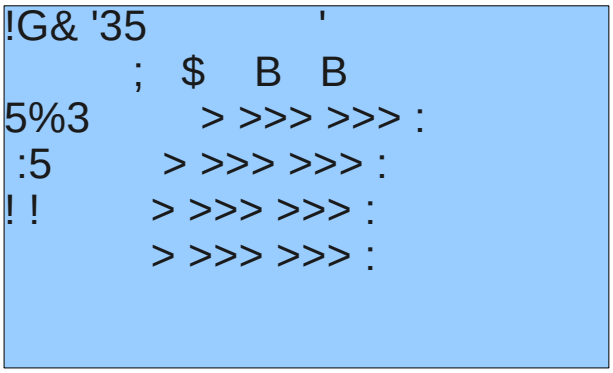

This screen allows you to enter and edit Expo and D/R values for the main controls (RUD/ELE/THR/AIL).

For each control you can input values for Left/Right for both Expo and D/R. To edit expo values highlight the value in the “expo” column and press [MENU]. Once the cursor blinks you can use the [UP]/[DOWN]/[LEFT]/[RIGHT] buttons to change the value. Notice that while there is a telltale that shows you which side of travel you are adjusting:

"-”: This means both left and right values are equal. Pressing [UP]/[DOWN]/[LEFT]/[RIGHT] will change values simultaneously.

"←”, “→” : When moving the stick you can see either of these symbols. When this symbol is visible you are only changing that side of travel.

For each control you can set 2 switches. The main switch changes between high rate/high expo and mid rate. If the main switch is “low” (e.i. mid rate) the second switch can switch between mid and low rate.

At the end of each line there's a telltale that shows you which rate you are on:

H: High.

M: Medium.

L: Low.

Pressing [MENU LONG] while the cursor is on a control will take you to the Edit Expo/Dr screen. In this screen you can adjust the values for that single control. You will also see a graph indicating the action of that control. Press [EXIT] to return to the main Expo/Dr screen.

The "F.Mode" switch can be used as a triple rate switch for any one axis, or it can be used as a triple rate flight mode switch, controlling rates and expos for some or all of the flight axes at once. To use it as a triple rate/flight mode switch, set sw1 to "!ID2" and sw2 to "!ID1" If you want rudder, elevator, and aileron all assigned to this switch for flight modes, be sure to set sw1 and sw2 as above for each axis. With the switch in the up position, it will be at low rate, as indicated by the "L" at the end of the line. In the mid position, it will be mid rate, and at the down position, it will be at high rate. You can also include throttle if you'd like, to have different expo curves for each of the flight modes.

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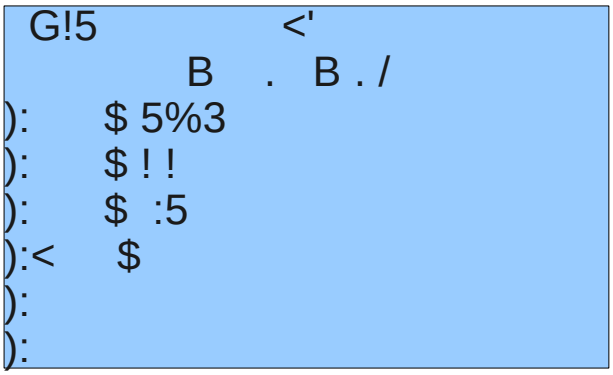
I'm actually writing this last since it's the most important menu. If you're still awake now would be a good time to sip that coffee and wake up. You want to understand ER9x? Understand the mixer and you're very nearly there.

The function of the mixer is to take the inputs, perform some function on them and rout them to the output channels. Since selection is totally free you have a very flexible system which is extremely powerful and very quick to boot.

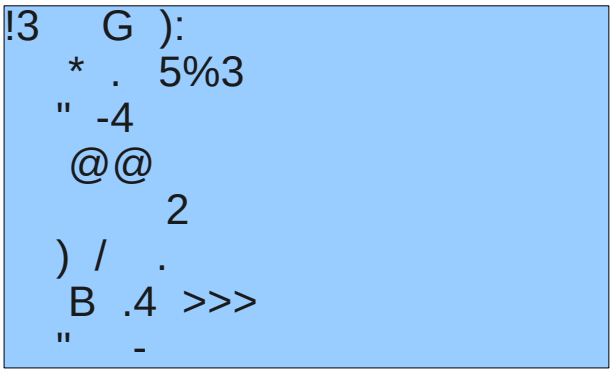
When you enter the screen for the first time you'll probably see a list like so:



What this is telling you is that the rudder stick's input is being routed with a weight of 100% to CH1. Same for the elevator, throttle and aileron. Though not visible now you can also see the switch column which will tell you if a switch is assigned to the mix and also a crv (curve) column which tells you what curve is applied to that mix.

When you scroll down you'll see that sometimes the weight is being highlighted and sometimes the channel's number is underlined. When the weight is highlighted, pressing [LEFT]/[RIGHT] will edit that value and pressing [MENU LONG] will enter the Edit Mix screen and allow you to edit that mix. When the channel's number is underlined, pressing [MENU LONG] will insert a new mix for that channel and take you to the edit mix screen for it.

You can also press [MENU]. This will highlight the mix. Then you can press [UP]/[DOWN] to move or copy the mix. Notice that moving or copying is decided by whether you press up or down on the first press after highlighting the mix. If you first try to move it down it will be copied. Subsequent presses of [UP]/[DOWN] will move the copy up or down until you press [MENU] or [EXIT]. Pressing [UP] will move the mix without copying it. Again, subsequent presses of [UP]/[DOWN] will move the copy up or down until you press [MENU] or [EXIT].



In this screen you edit individual mixes.

Here are the available options for each mix:

1. Source: This is the input for the mix. It can be the following:
   i. Stick or pot: Self explanatory.
   ii. MAX: The output is either 0 or the value describes in “weight”. This is controlled by the switch.
   iii. FULL: Same as MAX but the value is “-weight” if the switch is off or “weight” if the switch is on.
   MAX and FULL can be a little confusing. Look in the examples section for, well, examples :).
   iv. PPM1..PPM8: PPM input channels. These are fed by the ppm input or “trainer port”. You can use these to configure a buddy system or to simply extend your radio with more functions (like head tracking for you FPV guys).
   v. CH1..CH16: These are the outputs of the other mixes. You can use these to chain mixes for very complex behavior.
2. Weight: This value multiplies the value from the input. It can be -125% to 125%.
3. Offset: This value is added to the value from the input. It can be -125% to 125%.
4. Trim: When this is “ON” the trim value (if exists) will be carried on through the mix. When “OFF” it is ignored.
5. Curves:
   i. x>0: The value of the source is carried through only if it is positive (greater than zero). Otherwise it is zero.
   ii. x<0: Same but for negative values.
   iii. |x|: The value is passed as an absolute value.
   iv. f>0: If source is positive then the output value is “+weight” otherwise it is 0.
   v. f<0: If source is negative then the output value is “-weight” otherwise it is 0.

vi. |f|: Output is either “+weight” or “-weight” depending on the sign of the source.

vii. c1..c16: custom curves. These are defined in the “CURVES (6/8)” screen. You can also press [MENU] to edit the curve directly.

6. Switch: Here you select the switch that operates the mix. If the switch is not selected then the mix is on by default.
7. Warning: Here you can select an audible warning that will sound whenever a mix is active. (This will only work when a switch is defined). You have an option of 1, 2 or 3 beeps. The warnings will sound in succession so you can hear them individually.
8. Multpx: This value defines how the mix will be added to the channel.
   i. Add: This is the default value. With this value the mix is added to the previous values in the same channel.
   ii. Multiply: Use this to multiply the previous values in the same channel.
   iii. Replace: This value is used in conjunction with a switch. When the switch is off the value is ignored. When the switch is on the value discards the previous values and places it's own value in the channel.
9. Delay Down/Up: Use this to delay use of this channel. Usually used with a switch. When the switch is turned “ON” or “OFF” the mixer will wait the specified number of seconds before changing the value.
10. Slow Down/Up: Slow the rate of change in the channel. When not zero these will determine the maximum speed with which the value can change. The specified value is the number of seconds to go between -100% to 100%.
11. DELETE MIX [MENU]: Pressing [MENU LONG] here will delete the mix and return to the main mix screen.

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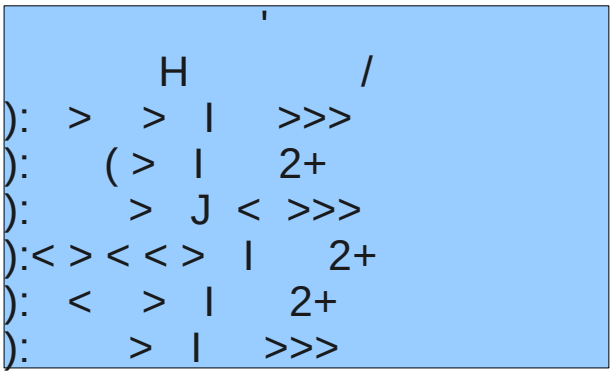

This is probably the second most important menu.
The limits operate on the output channels (as you can see from the flow chart in the introduction). In the LIMITS menu you can set the center point (subtrim), limits (both left and right) and reverse the channel's output (inv – invert).

Each channel here corresponds to a channel in your receiver. The limits you set will be used on that channel only.

Columns:

1. subT: SubTrim. This sets the channel's center point. Please notice that the position of the limits is based on the center point. When subT changes their absolute position moves with it.
   HINT: The values of subT can be -100 to 100 with increments of 0.1. This is done so to have excellent resolution when setting the center of each surface. You can use your stick to set the center point as well. While the subT is highlighted hold the stick so that the surface is centered. Press [MENU LONG] and the position will be recorded! It's the magic of ER9x again :).
2. Min/Max: These set the endpoints of the channel. Notice that there's a telltale that hints as to which side is active at the moment. Each limit point can range between -125% to 125%.
   The limits act both as gains and as absolute limits. The servo will not go beyind the limits you set here.
3. inv: Invert. This function reverses the output of the channel.

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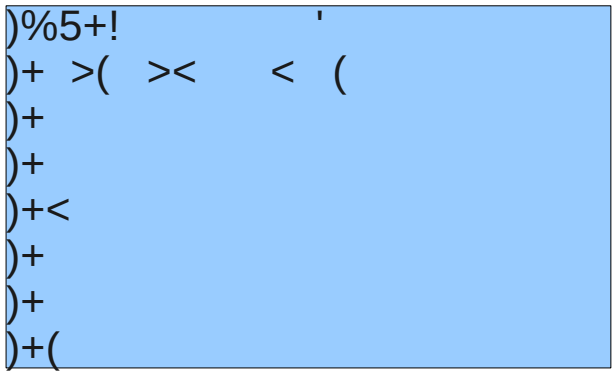

Surprisingly in this menu you set your custom curves. Curves are nifty things that can tell your servo how to move when you move your stick. In ER9x there are 8 5point curves and 8 9pointt curves.

A 5pt curve is a curve you can edit at position -100%, -50%, 0%, 50%, 100%.
A 9pt curve is a curve you can edit at position -100%, -75%, -50%, -25%, 0%, 25%, 50%, 75%, 100%.

When you enter the menu you see a long list of zeros. Scroll down to the curve you wish to modify and press [MENU]. This will bring up the screen for editing the curve. Depending on whether you chose a 5pt or a 9pt curve you will see 5 or 9 editable points. Scroll through the points with [UP]/[DOWN]. Change the value with [LEFT]/[RIGHT].
At the bottom you will see a “preset” entry. Pressing [LEFT]/[RIGHT] on that will populate the values with a linear curve that is a good starting point.

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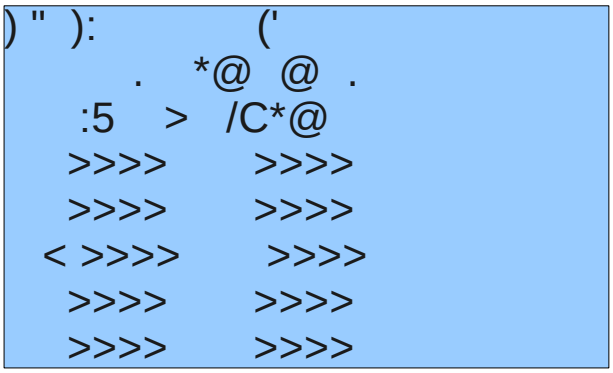

I really like this feature.
Custom switches are not really switches at all but rather a set of logical conditions that can be used as switches.

You might have noticed that beyond the physical switches there are 6 switches called SW1..SW6. These correspond to the list you see in this screen. Once the condition defined for the switch is met it's value will be “ON”.

1. To define a custom switch you need to define a source. This can be a stick, a pot, a PPM input or an output channel.
2. Next we define an offset. This can be anywhere between -100 and 100. This will be the test point for the condition.
3. Lastly we define the condition. This can be v>offset, v<offset, |v|>offset and |v|<offset. The offset is the value we set in step 2 and “v” is the value of the source we set in step 1.

Example:
Say you have a glow plug driver which you want to turn on when the throttle is below 10%:

1. Highlight SW1
2. Select the source as THR.
3. Select the offset as -80 (remember -100 – 100 so 10% from idle is -80).
4. Select the condition as v<ofs.

Now you need to use a mix to run the switch. Go to the mixer menu. Select the CH8 as the channel you want the GP driver to operate on. On that channel select source as “MAX” and Switch as “SW1”. Now whenever the throttle goes below 10%, CH8 will go to 100%. Cool, huh?

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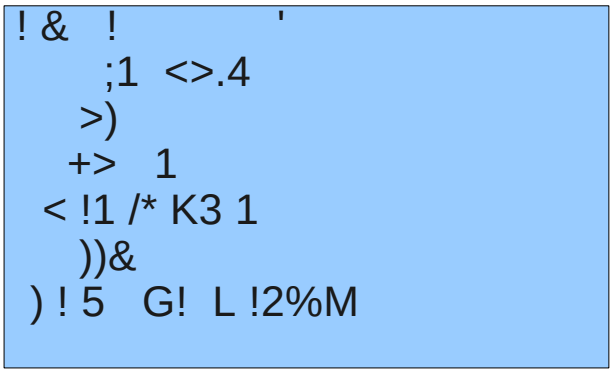

The templates are there to help you get started. When entering the screen you'll see a list of available templates. To choose a template, scroll down to it and press [MEU LONG]. This will the template to the existing mixes.

At the bottom you'll see an option called “CLEAR MIXES [MENU]”. Pressing [MENU LONG] on this will clear all the mixes leaving you with a clean slate.

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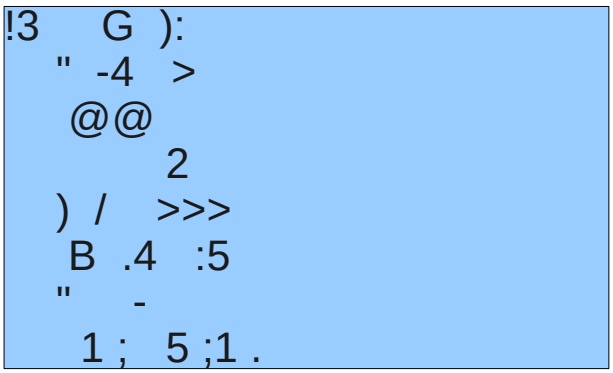

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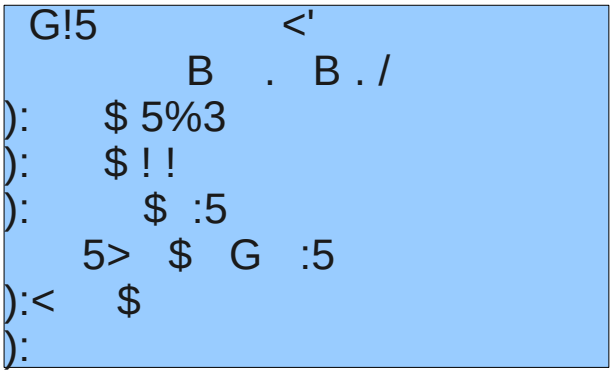

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Unmanned Photography

Appendix C

Standard Operating Procedures

UNMANNED PHOTOGRAPHY

STANDARD OPERATING PROCEDURES

PREFLIGHT CHECKLIST

Safety for the public on the ground as well as manned aircraft above is an essential consideration for aerial photography, surveying and mapping. As such, safety protocol and control must be implemented through pre-flight preparation and during aerial operation.

ENVIRONMENTAL:

□ Check weather forecasts for wind advisory or other conditions that may impact flight
□ Notify any bystanders or nearby property owner of your intentions.
□ Consult five (5) mile radius map for airport vicinity
- Contact respective airport to advices of estimated flight time, estimate flight duration, estimated elevation of flight, and any other pertinent information

□ Inspect flight area for:
- Vicinity of public safety helipads/heliports
- Vicinity of medical helipads/heliports
- Vicinity of light poles
- Vicinity of utility wires
- Vicinity of trees
- Flocks of birds that may cause interference and potential flight impact
- Vicinity of any elevated obstructions that may pose potential flight hazard
- Vicinity of roadway with moderate to heavy traffic that can be distracted
- Public gathers that may attract viewers

□ Takeoff and landing
- Inspect area for best and safest point of takeoff and landing
- If in a subdivision or area that is within 150 feet of a residential street, post warning sign(2)/stand(s) “Attention Aerial Photography/Surveying/Mapping In Progress – Remain Back 150 Feet”

□ First Aid / Safety Kit on hand, stocked, readily accessible, and visible to anyone in the area

HARDWARE / EQUIPMENT:

VISUALLY INSPECT THE AIRFRAME

□ Cracks (especially in high stress areas like joints)
□ Loose or damaged screws / fasteners / bands / straps / ties
□ Loose or damaged wiring
□ Loose or damaged connections (solder, plugs, etc)
□ Inspect prop mounts & screws & apply slight counter pressure on arms to check for loosened construction
□ Inspect camera lens and ensure that cameras are secured
□ Battery/batteries fully charged, properly seated & secured
□ Remove props and test fail-safe behavior (if applicable)
□ Props are smooth and free of damage/defect (check blade, surface, & hub)
□ Tighten prop adapters (careful not to over tighten which may damage prop)
□ Ensure voltage alarm is connected
□ Ensure arming/idle timeout is properly configured (6-15 seconds is generally acceptable)
□ Check whether the right model is selected in the transmitter (if applicable)
□ Check your RC transmitter shows the right range and centering for all sticks
□ If desired, perform range test

UNMANNED PHOTOGRAPHY

STANDARD OPERATING PROCEDURES

PRE-FLIGHT:

POWER UP

□ Batteries charged & secured
□ Position UAV in a level, safe location for takeoff
□ Power up ground station and video receiver
□ Turn on camera
□ All transmitter controls move freely in all directions
□ All transmitter trims in its neutral position
□ All transmitter switches in correct position (typically away)

□ Transmitter throttle to zero
□ Radio transmitter on
□ Connect/power on battery to airframe
□ Ensure led indicators & audible tones are all correct
□ Timer on (if applicable)
□ Scan for nearby people or animals
□ Stand clear - audibly, loudly announce the word "CLEAR!"
□ Arm flight controller

PRE TAKEOFF

□ Increase throttle slightly listening for any abnormalities
□ Short 20-30 second hover at 3-5 feet
(listen for any weird vibrations or anything that sounds loose)

FLIGHT:

□ Takeoff and land from same location
□ Remain alert to birds, sound or aircraft, curious public, and approaching vehicles
□ Do not allow anyone to engage in conversation or distract the remote control pilot
□ Restrict flight to minimal elevation sufficient to acquire desired results
□ Remain prepared for emergency landing at all times
□ Pay attention to flight time and set a timer as a safety alert
□ Land UAS and shut down propulsion immediately following landing

POST FLIGHT:

□ Disconnect battery to prevent accidental activation of propulsion system
□ Secure UAS in a safe location
□ Remove all warning signs from public access areas

Emergency or Suspected Hazard:

□ Immediate land UAS at safest and closet ground location in the event:

- Manned aircraft is heard or seen in vicinity of flight
- There is a public gathering within established safety boundary wanting to observe flight
- Pilot is being distracted from focusing on flight and safety
- Sudden change in weather (wind bursts)
- Sudden increase in vehicular traffic in vicinity of flight
- Birds enter into proximity of flight
- Any sudden unsafe event that can cause collision, distraction or interruption of control

Unmanned Photography

Appendix D

Flight Log

UNMANNED PHOTOGRAPHY
FLIGHT LOG

Date: _____
Location: _____

Pre-Flight Inspection: Yes No

Elements	**Circle**	**Circle**	**Comment**
Weather	Good	Fair	_____
Visibility	Good	Fair	_____
Wind Speed	Low	Medium	_____

Proximity to Airport: _____

Airport Notified: **Yes** **No** **Date:** _____ **Time:** _____
Phone Number: _____ **Contact Name:** _____

Nearest Major Intersection: _____

Proximity to Medium Traffic Road: _____

Proximity to Heavily Traveled Road: _____

Takeoff Time: _____
Landing Time: _____
Estimated Elevation: _____

Comments: _____
_____
_____
_____
_____

Safety for the public on the ground as well as manned aircraft above is an essential consideration for aerial photography, surveying and mapping. As such, safety protocol and control must be implemented through pre-flight preparation and during aerial operation.